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Mercury Contamination in East Fork Poplar Creek and Bear Creek

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ENVIRONMENTAL SCIENCES DIVISION
Publication No. 2051

OAK RIDGE NATIONAL LABORATORY

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ABSTRACT

VAN WINKLE, W., R. W. COUNTS, J. G. DORSEY, J. W. ELWOOD, V. W. LOWE, JR., R. McELHANEY, S. D. SCHLOTZHAUER, F. G. TAYLOR, JR., and R. R. TURNER. 1982. Mercury contamination in East Fork Poplar Creek and Bear Creek. ORNL/TM-8894. Oak Ridge National Laboratory, Oak Ridge, Tennessee. 84 pp.

A one-month study was performed at the request of Y-12 Plant management to determine the concentration of mercury in sediment, fish, moss, and pasture grass in the East Fork Poplar Creek (EFPC) and Bear Creek drainages and to determine whether mercury is still being released from the Y-12 Plant.

Total mercury concentration in a sediment core from New Hope Pond was 100 µg/g dry wt at the surface and up to 300 µg/g dry wt in subsurface sediments, relative to background concentrations of less than 0.3 µg/g dry wt. There has been an apparent decrease since 1973 in mercury concentration of sediment entering New Hope Pond. The decrease since 1977 may be due to the absence of high runoff-producing storms since 1977, although one or more intermediate layers in the core need to be dated to establish the absolute chronology of mercury deposition in New Hope Pond over the period 1973-1982. Mercury concentration in sediment of EFPC immediately below New Hope Pond is similar to the concentration in the surface sediment of New Hope Pond, thus suggesting a common and currently active source for the mercury in the creek and the pond. Mercury concentration in the sediment decreases with distance downstream, indicating dilution of the contaminated sediment with uncontaminated sediment from tributary drainages entering East Fork Poplar Creek. Mercury concentration at all stations on EFPC exceeded background by a factor of 60 or more.

Total mercury concentration in muscle tissue of bluegill from EFPC was positively correlated with body weight, as expected. Although there was a decrease in concentration with distance downstream, mercury concentration in 87% of the bluegill collected at the three upstream locations exceeded the Food and Drug Administration (FDA) action level for mercury in the edible portion of fish of 1.0 µg/g fresh wt. Total mercury concentration in moss, as in sediments and bluegill, decreased with distance downstream in EFPC. Total mercury concentration averaged 3.5 and 0.2 µg/g fresh wt for dead and live foliage in pasture grass, respectively, on the flood plain of EFPC. Calculations indicate that mercury concentration in milk from cows grazing along EFPC presents no health hazard, but calculations indicate that mercury concentration in beef may exceed 1.0 µg/g fresh wt.

Results for Bear Creek indicate that this drainage is considerably less contaminated with mercury than East Fork Poplar Creek. The concentration in the sediment was 13 µg/g dry wt near the settling basins at the west end of the Y-12 Plant area, but decreased to background concentrations before the confluence of Bear Creek with EFPC. Total mercury concentration in fish, except for one rock bass, did not exceed the FDA action level. The concentration in moss was slightly above background, but was more than a factor of 10 lower than that for moss from EFPC.

Recommendations are made (1) to limit the quantity of mercury released from the Y-12 Plant area into EFPC, (2) to consider notifying the responsible state agencies and fishermen concerning mercury concentrations found in fish in EFPC, and (3) to measure mercury concentration in hair from cattle grazing on pasture grasses along EFPC. Recommendations concerning further monitoring are also made.

1. INTRODUCTION

In April 1982, the Environmental Sciences Division at Oak Ridge National Laboratory, in collaboration with analytical chemists and statisticians from the Y-12 Plant, was requested to design, execute, and report on a short-term study of mercury contamination in East Fork Poplar Creek (EFPC) and Bear Creek (BC), the two drainages for the Y-12 Plant area. The objectives, in order of priority, were to determine (1) the concentration of mercury in fish, other biota, and sediment of EFPC as of May 1982, (2) whether mercury continues to be released from the Y-12 Plant, and (3) the concentration of mercury in fish, other biota, and sediment of BC (memo from D. L. Mason to J. G. Dorsey et al., dated May 4, 1982). A fourth objective, not covered in this report, was to determine the concentration of PCBs and uranium in fish, other biota, and sediment in East Fork Poplar Creek and Bear Creek.

The study was constrained by the requirement that the work be complete by May 21, except for this report itself. As a result, sample types, number of sampling stations, and number of samples were selected to result in approximately 150 analyses for total mercury.

2. SITES AND METHODS

Samples of sediment, fish, moss and liverwort, and pasture grass were collected at a number of locations along the length of East Fork Poplar Creek and Bear Creek (Table 1 and Fig. 1). In addition, a sediment core was taken in New Hope Pond for the purpose of determining the historical record of mercury contamination in this pond. The following four subsections describe the sites and methods used for each of the four sample types, while Subsections 2.5 and 2.6 describe analytical procedures, precision, and accuracy.

2.1 SEDIMENT

2.1.1 New Hope Pond (NHP)

2.1.1.1 Sites

A single 7.5-cm i.d. x 95-cm deep sediment core was collected in the central portion of NHP on May 5, 1982. The actual coring site (about 10 m west of rock outcrop) was selected after several trial coring sites located in other areas of the pond yielded cores with very similar appearance and total sediment thickness ($\sim$ 1 m). All cores bottomed out in hard substrate consisting of a tan clay with angular gravel (chert) inclusions. The top of this hard substratum is presumed to have been the bottom of NHP after the last major dredging activity in 1973. Thus, the overlying sediment column (95 cm in thickness) is assumed to have been deposited since the last major dredging of the central portion of NHP.

Table 1. Station number, location, and type of sample collected at each site on East Fork Poplar Creek and Bear Creek

Station		Sample type			
Number	RK (RM)[a]	Sediment	Fish	Liverwort and moss	Pasture grass
		East Fork Poplar Creek			
1	2.1 (1.3)	X	X	X	
2	7.7 (4.8)	X		X	
3	8.8 (5.5)				X
4	10.9 (6.8)	X			
5	13.4 (8.3)	X	X		X
6	22.2 (13.8)	X		X	
7	22.7 (14.1)	X	X		
8	22.8 (14.2)	X	X		
		Bear Creek			
1	0.6 (0.4)	X	X		
2	3.2 (2.0)			X	
3	4.5 (2.8)	X			
4	9.7 (6.0)	X			
5	11.4 (7.1)	X			
6	12.2 (7.6)	X			

[a]River kilometer (river mile) relative to confluence with Poplar Creek for East Fork Poplar Creek and relative to confluence with East Fork Poplar Creek for Bear Creek.

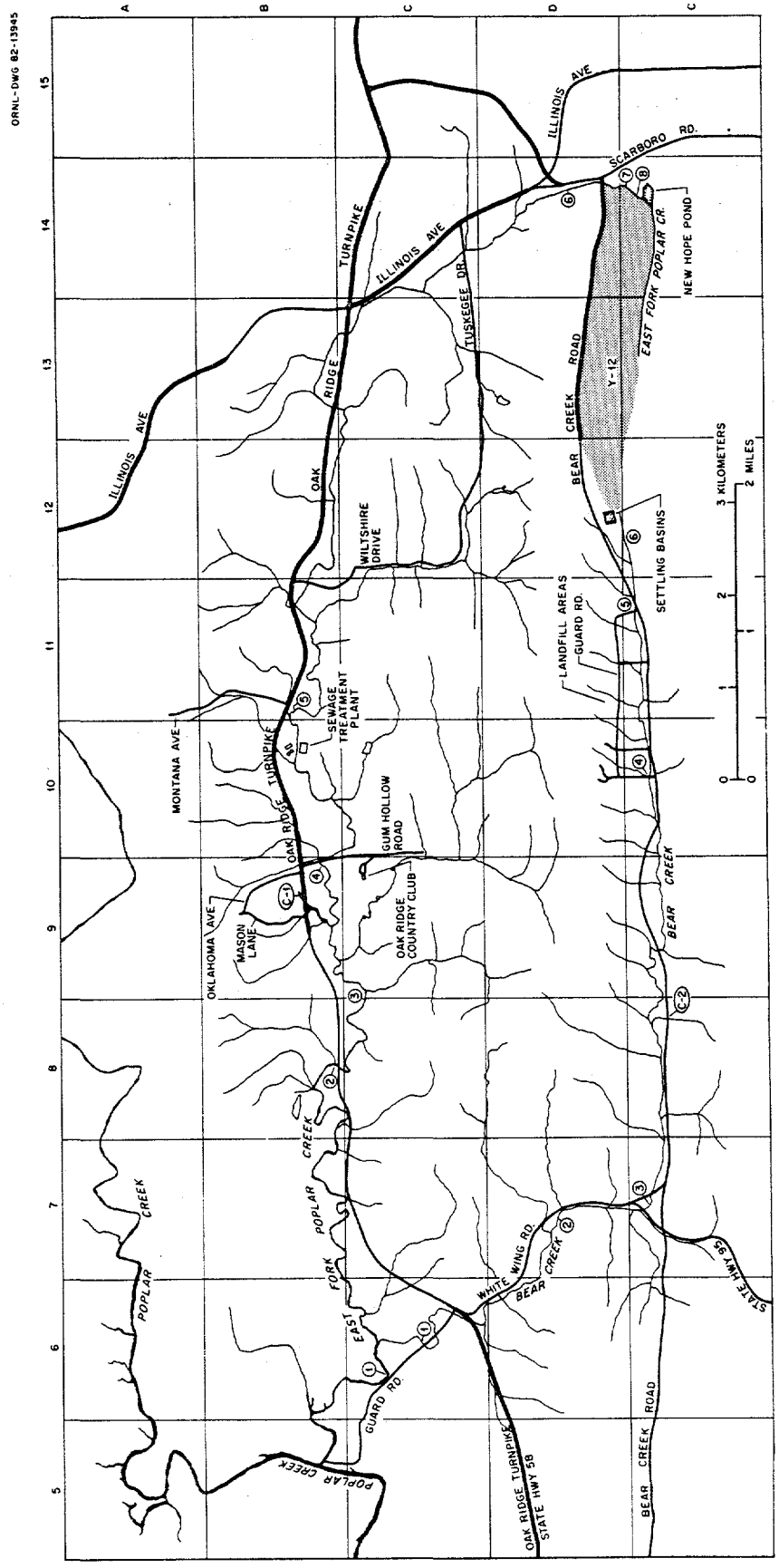

Fig. 1. Location of sampling stations on East Fork Poplar Creek and Bear Creek. Table 1 gives types of samples collected at each station. Sites C-1 and C-2 are control stations for sediment samples.

2.1.1.2 Methods

The sediment core from NHP was obtained by manually pressing a length of transparent, thin-walled polycarbonate tubing (7.5-cm i.d.), open at both ends, vertically into the bottom of the pond. When the tubing could not be pressed further into the bottom, the air space in the upper portion of the tubing was filled with water and the top end of the tubing sealed with a rubber stopper. The tubing was then pulled upward until the lower end could also be sealed. Then the upper portion containing only water was removed by cutting about 2 cm above the sediment-water interface (visible through the transparent tubing) and the lower portion containing the sediment core was resealed using a rubber stopper. Because the upper layers of sediment had a relatively high percent moisture (> 60%), the core was maintained in a vertical position to prevent disturbance and mixing of older (deeper) layers with younger (shallower) layers.

To facilitate extrusion of the core with minimal disturbance of sediment, the core was transferred immediately to the walk-in freezer at the Comparative Animal Research Laboratory (CARL) located about 2 km from NHP. The following day (May 6) the core was retrieved from the freezer and extruded onto a sheet of plastic. The outer 0.5 cm of the core was found to be completely frozen. This frozen material was trimmed away (and discarded) and the interior portion sectioned at 5-cm intervals. Although the interior portion was not frozen, enough water had been drawn to the outer portion and frozen that the interior was stable enough to subsample without mixing layers.

The continuous 5 cm-sectioning interval yielded 19 subsamples from the core. Each subsample was placed on a sheet of aluminum foil and thoroughly blended with a stainless steel spatula. A small aliquot (< 50 g wet wt) was separated to serve as an archive sample of the original moist material. These archive samples were placed in plastic bags and frozen. The remainder of each subsample (∿ 100 g wet wt) was weighed and then placed overnight in a forced-air drying oven at 50°C. The dried sediment was weighed and ground to a fine powder with a mullite mortar and pestle. Fourteen of the 19 subsamples were submitted to the Y-12 analytical laboratory. The subsamples from 55 to 60 cm, 65 to 70 cm, 75 to 80 cm, 85 to 90 cm, and 90 to 95 cm were retained for possible later analysis.

Except for the bottom two sections (85-90, 90-95 cm), the texture of the entire length of the NHP core was field classified as silty clay. Thus, any differences in particle size distribution among sections were not expected to confound interpretation of mercury concentrations as a function of depth in the core.

2.1.2 East Fork Poplar Creek (EFPC) and Bear Creek (BC)

2.1.2.1 Sites

Surface sediments were collected from EFPC and BC on May 7, 1982, at the locations described in Table 2. Grid quadrants given in the table are taken from the 1:24,000 topographic map (S-16A, 1974) of the Oak Ridge area prepared by TVA for the AEC-ORO Office.

Fish and
Surface sediment sampling

Table 2. Location and description of sampling sites in East Fork Poplar Creek, Bear Creek, and tributary creeks used as control sites (see Fig. 1)

Station number	Site description	RK (RM)[a]	Grid quadrant[b]
	East Fork Poplar Creek (EFPC)		
1	Approximately 500 m downstream of confluence with BC	2.1 (1.3)	C-6
2	Downstream of Route 95 bridge-crossing	7.7 (4.8)	B-8
4	Downstream of Gum Hollow Rd. bridge-crossing (adjacent to Oak Ridge Country Club)	10.9 (6.8)	B-9
5	Immediately south of the intersection of Montana Ave. and the Oak Ridge Turnpike	13.4 (8.3)	B-11
6	West of old guard house on Scarboro Rd. 500 m north of Bear Creek Rd. intersection with Scarboro Rd.	22.2 (13.8)	D-14
7	Approximately 100 m downstream of the large stormwater inlet mentioned for Station 8	22.7 (14.1)	E-14
8	Between NHP discharge point and first large stormwater inlet on west bank approximately 50 m downstream	22.8 (14.2)	E-14
	Bear Creek (BC)		
1	Downstream of 3rd bridge (counting from Route 95) across BC on gravel guard road northeast of McKinney Ridge near USGS Bench Mark BM LK 90	0.6 (0.4)	C-6

Table 2. continued

Station number	Site description	RK (RM)[a]	Grid quadrant[b]
	Bear Creek (BC)		
3	At permanent NPDES monitoring station near intersection of Bear Creek Rd. and White Wing Rd.	4.5 (2.8)	E-7
4	Upstream of westernmost gate to landfill areas on north side of Bear Creek Valley Rd.	9.7 (6.0)	E-10
5	Upstream of easternmost gate to landfill areas on north side of Bear Creek Valley Rd.	11.4 (7.1)	E-11
6	Approximately 200 m west of settling basins at the west end of the Y-12 Plant	12.2 (7.6)	E-12
	Control (C)		
1	Tributary to EFPC downstream of spring on north side of Oak Ridge Turnpike between Oklahoma Ave. and Mason Lane	-	B-9
2	Tributary to BC at Bear Creek Rd. crossing west of power line right-of-way, originating on north slope of Chestnut Ridge	-	E-8

[a]River kilometer (river mile) relative to confluence with Poplar Creek for East Fork Poplar Creek and relative to confluence with East Fork Poplar Creek for Bear Creek.

[b]From topographic map S-16A (1974) of the Oak Ridge area.

2.1.2.2 Methods

Sediment samples from EFPC, BC, and two control (local background) tributaries were collected by manually scooping up surface layers (upper 1 cm or less) of sediment from three to ten areas of active deposition located within 50 m of each sampling station (Table 2). These subsamples were composited into the same container. The depositional areas consisted of quiescent, or less turbulent, waters on the lee side of snags, rocks, sandbars, and debris dams. All creek samples were obtained at or below the current water surface.

Each composite creek sample was wet-sieved in the laboratory using a 20.3-cm-diam stainless steel sieve of 0.125-mm mesh size (No. 120). Material retained in the sieve was discarded. Material passing through the sieve was transferred to 1-L polypropylene bottles and centrifuged at 1200 rpm for 10 to 20 min to permit decanting of the excess water added during wet sieving. The dewatered sediment was transferred to sheets of aluminum foil and dried overnight at 50°C in a forced-air drying oven. The dried sediments were placed in plastic bags and sent to the Y-12 analytical laboratory where they were homogenized prior to subsampling for analysis. Homogenization was accomplished by crushing the sediment in a heavy plastic bag using a rubber mallet.

2.2 FISH

2.2.1 Sites

Fish were collected at four locations in East Fork Poplar Creek below New Hope Pond and at one location on Bear Creek. For consistency the sample station numbers are the same as those used for the sediment samples. The only difference is that fish were collected at fewer

stations and over a longer reach of stream than were the sediment samples. Fish sampling sites in EFPC were (see Table 2): Station 1 (approximately 500 m downstream of confluence with BC), Station 5 (immediately south of the intersection of Montana Avenue and the Oak Ridge Turnpike), Station 7 (approximately 100 m downstream of large storm drain on the west bank located 50 m below the outlet of NHP), and Station 8 (between NHP outlet and the storm drain located 50 m below NHP outlet).

The location of the fish sampling station on BC corresponds to that of Station 1 for sediment (Table 2), except that fish were collected over a reach extending 50 m upstream of the third bridge over Bear Creek.

2.2.2 Methods

Fish were collected by electrofishing on May 6 and 7, 1982. Because of time constraints on the total number of samples that could be analyzed for this preliminary study, only one species of fish, bluegill (*Lepomis macrochirus*), was collected for mercury analysis at most sampling locations. Bluegill are distributed throughout the EFPC and are found in BC as well, thus allowing comparisons of mercury concentrations in a common species of sport fish among all sampling locations. Unfortunately, only a few bluegill were collected in the BC sample. However, rock bass (*Ambloplites rupestris*), which are in the same taxonomic family and have similar food habits as bluegill, were abundant in Bear Creek and so were collected from this site for mercury analysis. A few specimens of largemouth bass (*Micropterus*

salmoides) and white bass (Morone chrysops) also were collected for mercury analysis.

Fish collected from each station were placed in plastic bags and stored in an ice chest. Upon return to the laboratory, the fish were either processed immediately or stored in a refrigerator at 3°C. Prior to filleting, all fish were washed in tap water, weighed fresh (i.e., uncut) to the nearest 0.1 g, and measured (standard length) to the nearest millimeter. The sex of fish with sufficiently developed gonads for identification also was recorded.

Most of the axial muscle was removed from each fish using a stainless steel fillet knife. The skin was removed from each fillet, either during the filleting or before the fillet (or an aliquot thereof) was weighed at the Y-12 Plant laboratory prior to digestion for mercury analysis. The individual fillets from each fish were placed in separate plastic bags and frozen immediately at -14°C. The fillets were then transferred in a frozen condition to the Y-12 Plant laboratory for total mercury analysis. All mercury concentrations for fish in this report are on a microgram per gram (µg/g) fresh weight basis.

2.3 MOSS AND LIVERWORT

Moss (species not identified) and liverwort (Marchantia sp.) samples were collected May 6, 1982, along East Fork Poplar Creek and Bear Creek at the same four stations sampled on December 5, 1981, by an ORNL employee and a U.S. Geological Survey (USGS) employee.

2.3.1 Sites (see Tables 1 and 2)

2.3.1.1 East Fork Poplar Creek

Station 1. Moss was collected approximately 10 cm above the waterline from the vertical face of a large limestone rock on the south side of the creek.

Station 2. Moss was collected from the trunk of a fallen tree partially laying across the river. Filamentous algae mixed in with the moss were removed before the moss was placed in the sample bag.

Station 6. Moss was collected off tree roots located 10 to 15 cm above the waterline. Liverwort was collected from the west side of the creek about 10 to 15 cm above the waterline.

2.3.1.2 Bear Creek

Station 2. Moss and liverwort samples were collected along the east bank approximately 20 to 40 cm above the waterline.

2.3.2 Methods

All samples were placed in plastic bags and stored in an ice chest. Upon return to the laboratory, samples were stored over the weekend (3 d) in a refrigerator at 3°C, then divided into three replicates and delivered to Y-12 on May 10.

2.4 PASTURE GRASS

2.4.1 Sites

Vegetation transects were located on flood plains of East Fork Poplar Creek (EFPC) downstream from the Y-12 facility at approximately river kilometer 8.8 (Station 3) and 13.4 (Station 5) (see Tables 1 and 2). Livestock is currently pastured at Station 5, but at Station 3

such use ceased in autumn of 1981. The flood plain at Station 3 is maintained as a mixed fescue-blue grass pasture, whereas the cover at Station 5 is primarily fescue.

2.4.2 Method

Clip plots were located at 5, 30, and 100 m from the stream bank. The 100-m distance is above the high-water limit experienced during periodic flooding, whereas debris at 5 and 30 m indicated that the vegetation was inundated sometime during the past several months. Three replicate samples, each of standing live (1982 growing season) and dead (1981 growing season) foliage, were collected at each distance. Samples were sorted to remove materials other than grass and were frozen. Samples were later analyzed for total mercury and the concentrations reported "as received," (i.e., per unit fresh weight of sample in the condition in which the sample was received at Y-12).

2.5 ANALYTICAL PROCEDURES

The basic procedure for determining total mercury in a wide variety of materials was developed at ORNL and reported by Feldman (1974). Samples are digested under reflux with dichromate, nitric acid, and perchloric acid. The liberated mercury is reduced to the elemental state with stannous chloride and determined by the cold vapor atomic absorption technique.

Sediment samples were received already sieved and dried. A 2-g portion was digested and analyzed for mercury.

Fish samples were received as fillets and were kept frozen until ready for processing. A 5-g portion was sought, but because of the small size of some fish, anywhere from 1 to 5 g was actually weighed.

The samples were digested and duplicate aliquots were measured for mercury by the method of standard additions.

Moss and liverwort samples received the most extensive pretreatment. Samples were soaked overnight in tap water and picked clean by hand to remove sediment and extraneous plant material. They were rinsed one time each in tap water and deionized water and then dried for 24 h at 35°C. They were ground in a Wiley mill to pass a 1.3-mm screen and digested. A 2-g sample was sought after processing, but as little as 0.3 g for one sample was actually available. The digestion was slightly different for the aquatic vegetation samples in that the dichromate normally used was replaced by sulfuric acid.

Grass samples were received directly from the field and kept frozen until ready for processing. A 2-g portion of the dead foliage or a 5-g portion of the live foliage was digested and analyzed for mercury.

Method blanks were processed as samples to correct for any mercury in the reagents or the glassware. Ten percent of the samples were digested and analyzed in duplicate as a measure of precision. External, anonymous controls were analyzed as a measure of accuracy.

2.6. ANALYTICAL PRECISION AND ACCURACY

2.6.1 Sediment

Duplicate analyses were run on four of the sediment samples. The average coefficient of variation (C.V.) was 8.9% with a minimum of 0.0% and a maximum of 26%. A National Bureau of Standards (NBS) river sediment standard with a certified value of 1.1 ± 0.5 µg/g was submitted. This material was placed in a bottle identical to those

used for the NHP samples and labelled as if it came from NHP. The Y-12 Lab made two determinations; the results were 1.1 and 1.2 µg/g, indicating good accuracy at this level.

2.6.2 Fish

Analytical precision of total Hg determinations in fish muscle as determined by the average C.V. of all intralaboratory replicate analyses (i.e., whole analysis of duplicate muscle samples removed from fish and each analyzed for total Hg at Y-12) was 10.25 ± 3.14% (± 2 SE, n = 8); the C.V. ranged from 6.2 to 20.5%.

Analytical accuracy could not be determined with high reliability because a certified mercury standard for fish was not readily available. A portion of tuna fish having an NBS reference value (not certified) for Hg of 0.95 µg/g was analyzed three times by the Y-12 lab. The three results were 1.05, 1.21, and 1.07 µg/g (X = 1.11).

2.6.3 Moss and Liverwort

Replicate analyses were run on two of the moss samples. The C.V.'s were 5.6 and 2.1%, which compares favorably with the precision estimates for the other sample types.

One sample from each of three NBS standards was submitted to evaluate accuracy. These three standards were processed in the same manner as the moss and liverwort samples. The results from the Y-12 laboratory were 0.15 µg/g for pine needles (compared to the certified value of 0.150 µg/g), < 0.10 µg/g for bovine liver (compared to the certified value of 0.016 µg/g), and 0.15 µg/g for orchard leaves (compared to the certified value of 0.155 µg/g).

These results indicate consistently good accuracy at these lower concentrations.

In addition, the samples collected on December 5, 1981, and processed and analyzed by the U.S. Geological Survey (USGS) in Denver in their regional Geochemistry Laboratory, were available. Four samples, already ground in a Wiley mill to pass a 1.3-mm screen (see Section 2.5), were sent to Y-12 for an interlaboratory comparison. The Y-12 results are higher than the USGS results (or, equivalently, the USGS results are lower than the Y-12 results; see Section 3.2) by 11% (liverwort at Station 6) up to 78% (moss at Stations 1 and 2). This systematic difference for the interlaboratory comparison suggests that in any further study NBS standards having certified values in the 2 to 300 µg/g range be included in addition to the standards used for this study.

2.6.4 Pasture Grass

Analytical precision of total Hg determinations for pasture grass samples determined by the average C.V. of all replicate analyses was 10.00 ± 4.94% (± 2 SE, n = 8); the C.V. ranged from 0.0 to 19.6%.

Two samples from each of two NBS standards (orchard leaves and pine needles) were submitted to evaluate the accuracy of the method. The certified values for the orchard leaves and the pine needles were 0.155 and 0.150 µg/g, respectively. The two results on the orchard leaf standard were 0.39 and 0.27 µg/g (X = 0.33), whereas the two results for the pine needle standard were 0.15 and 0.17 µg/g (X = 0.16). The erroneously high values obtained for the orchard leaves are attributed to glassware contamination. The pasture grass

samples were the first samples from this study analyzed at the Y-12 laboratory, and as soon as the glassware contamination problem was discovered, it was successfully corrected as indicated by the results for the pine needle standard.

2.6.5 General

None of the NBS reference standards analyzed had mercury concentrations above 1.1 µg/g, while many of the sediment, fish, moss, and pasture grass samples had concentrations exceeding 1.1 µg/g (as high as 300 µg/g for sediments). Because of the greater potential error in mercury analyses at higher concentrations, due to the nonlinear relationship between mercury concentration and signal strength for the atomic absorption technique, reference standards containing mercury levels above 1.1 µg/g need to be analyzed, including the dilution procedure used for the sediment, fish, and moss sediments, to verify the total procedural accuracy of the analytical technique at these high concentrations.

3. RESULTS AND DISCUSSION

3.1 SEDIMENT

3.1.1 New Hope Pond (NHP)

The vertical distribution of mercury in the accumulated sediment in NHP was measured to answer the question: How has the input of sediment-bound mercury to this pond varied over time since the last major dredging of the pond?

To fully understand any historical record of contamination contained in NHP sediment requires consideration of past activities, especially maintenance dredging, that could alter the orderly deposition of fresh stream-borne sediment on top of previously deposited sediment. In this context, Y-12 personnel (Jim Underwood and Jim Bailey) provided the following information:

- Nearly all of NHP was completely dredged hydraulically (mud cat) in the spring or early summer of 1973.
- Since 1974 the diversion ditch on the south side of the pond, and the smaller catch-basin (oil skimmer) upstream of NHP, have been dredged annually using a clam shell dredge operated from the adjacent service road.
- A narrow (approximately 20-m wide) strip of NHP on the western side near the aerator was dredged in 1980 by a clam shell dredge operated from the adjacent service road.

The dredging that occurred in 1973 probably sets an upper limit on the maximum age of sediment in the pond. Assuming an orderly sedimentation regime, one can conclude that the deepest layers of sediment currently in the pond would represent material washed into the

pond from the Y-12 plant area about nine years ago. In the same way, the surface sediment currently in the pond would represent material washed into the pond recently (e.g., during the winter and spring of 1982). The annual dredging of peripheral areas (diversion ditch and oil skimmer basin) would not seem to constitute a serious challenge to the assumption that sediment layers deposited in the central portion of NHP represent increasingly older material with increasing depth. Even if the dredging of these peripheral areas resulted in the transfer of some of the material accumulated in these areas to NHP, the material would have originated from the Y-12 Plant area within the previous year and would not be more than approximately one year older than contemporaneous surficial sediment in NHP. In addition, the amount of sediment which might 'bleed' over into NHP during these annual activities would likely be small compared with the annual input of sediments to NHP derived from stormwater runoff.

The limited dredging in the western portion of NHP in 1980 could conceivably have remobilized older buried sediment and deposited it on top of younger sediment in other areas of the pond. Again, the quantities of older sediment which could be redistributed to other parts of NHP during the short period of limited dredging should have been small relative to the annual influx of runoff-borne sediment. Furthermore, the clam shell dredging was carried out with the water level in NHP lowered. Thus, circulation of resuspended sediments would be limited to the dredging area. Our coring site was located slightly east of the center of the pond and thus should not have been appreciably affected by this dredging.

Overall, the above considerations suggest that the dredging activities in and around NHP since 1973 should not seriously confound interpretation of vertical distributions of mercury and other contaminants in sediment cores.

Table 3 tabulates results of total mercury analyses on sediment layers from New Hope Pond. Mercury values are given on a dry weight basis but can be converted to a wet weight basis, if desired, using the 'percent moisture' values also given in the table. Displaying these data graphically (Fig. 2) reveals a pattern of generally increasing mercury concentration as depth in the core increases, with a superimposed broad peak in concentration 25 to 45 cm below the surface. The shape of the mercury profile below 55 cm is incomplete because only alternate 5-cm-thick layers were analyzed. However, the mercury concentration in the 80- to 85-cm layer (293 µg/g) is believed to be most representative of the oldest sediment in the pond. Both deeper layers (85-90 and 90-95 cm) contained intermixed gravel and tan clay, and showed no structures (i.e., distinct strata) suggestive of undisturbed sedimentation through water. In contrast, the layers between 60 and 85 cm contained distinct strata rich in coarse organic debris (probably from aquatic plants) alternating with fine-grained mud. This pattern of layering is characteristic of seasonal or shorter cycles of sediment deposition. Significant runoff events lay down the mud layers, whereas growth of aquatic plants during warmer months, and between periods of storm-turbidity-induced growth inhibition, accounts for the organic debris layers. Such alternating layers were absent or not visible in the upper 60 cm of the core which was also devoid of

Table 3. Total mercury concentration of New Hope Pond sediment layers. Core collected May 5, 1982, from central area of pond.

Sample code	Interval (cm)	Percent moisture[a]	Total Hg (µg/g dry wt)
NHP-1	0-5	80	107
NHP-2	5-10	68	108
NHP-3	10-15	64	116
NHP-4	15-20	70	110
NHP-5	20-25	68	122
NHP-6	25-30	61	174
NHP-7	30-35	54	240
NHP-8	35-40	59	220
NHP-9	40-45	47	278
NHP-10	45-50	52	170,166[b]
NHP-11	50-55	46	159
-	55-60	45	-[c]
NHP-13	60-65	43	220
-	65-70	43	-[c]
NHP-14	70-75	54	302
-	75-80	48	-[c]
NHP-15	80-85	47	292
-	85-90	30	-[c]
-	90-95	27	-[c]

[a](Wet weight - dry weight)/wet weight.

[b]Results of duplicate analyses.

[c]Sample not analyzed.

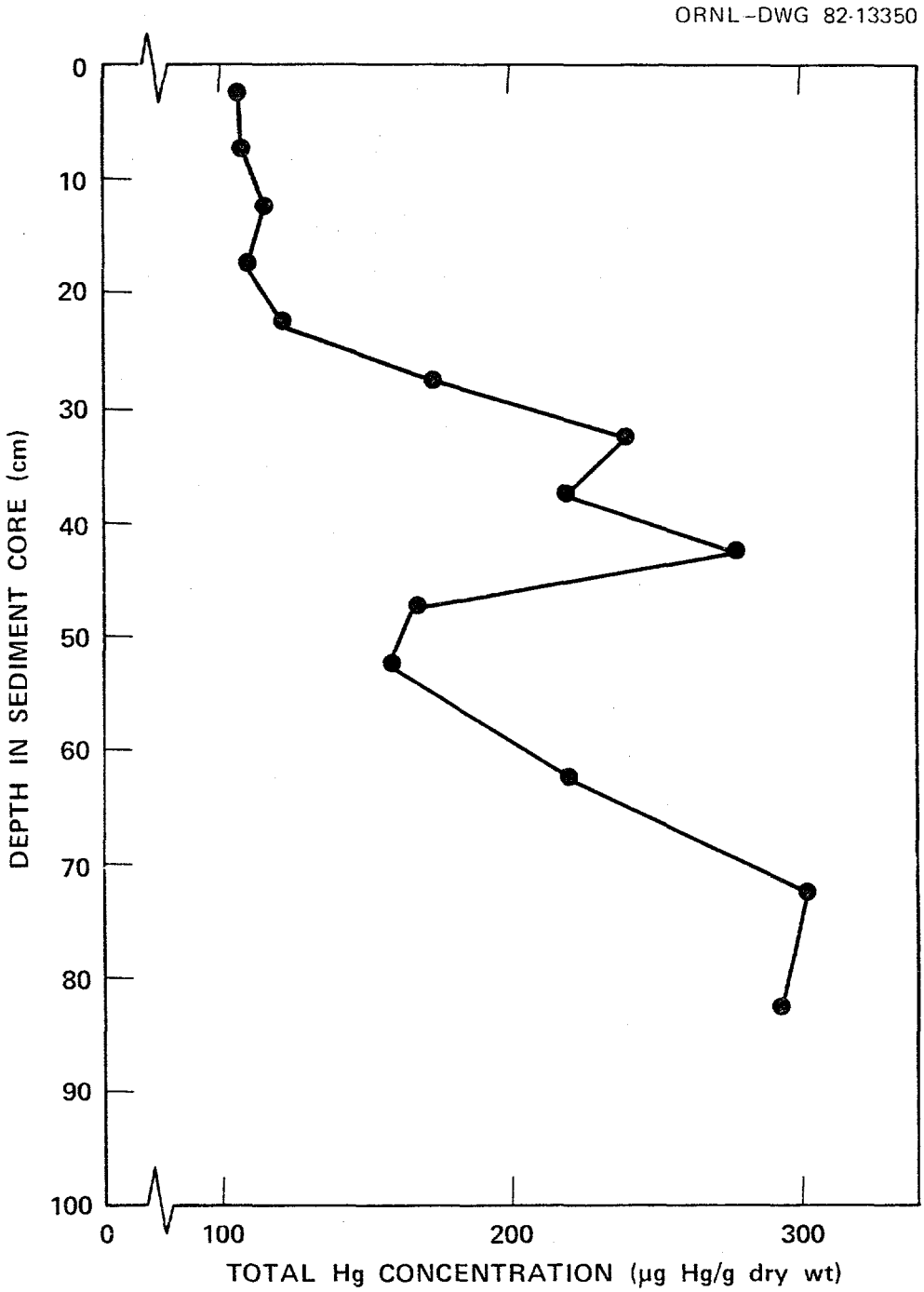

Fig. 2. Total mercury concentration as a function of depth in the sediment core taken from New Hope Pond, May 1982. Concentrations are plotted at the midpoints of the 5-cm layers. The concentration for the 45- to 50-cm layer is the average of two analyses, while concentrations for the other layers are based on single analyses. Results are for bulk samples (i.e., no sieving).

other sedimentary structures. The absence of such structures generally suggests continuous active mixing of the upper few centimeters of sediment by wave action and/or burrowing organisms.

In the context of the question concerning temporal changes in the input of mercury to NHP, the core results suggest that mercury input has decreased since the last major dredging (1973). Stated more precisely, comparison of mercury concentrations in the youngest (0- to 5-cm layer) and oldest (80- to 85-cm) sediments in NHP suggests that mercury levels in sediment washing into NHP have decreased from about 300 to about 100 µg/g. However, the broad peak in mercury concentrations between 25 to 45 cm (Fig. 2) suggests that the mercury concentration in sediment entering the pond has varied appreciably since the last major dredging, which precludes an unambiguous interpretation of the core results.

Additional information will be needed to determine whether or not a true temporal decrease in the mercury concentration in sediments washing into NHP has occurred. As a minimum, the following information would facilitate a better understanding of how the input of sediment-bound mercury has varied over time since 1973:

- Hydrologic records for the NPDES monitoring station located on the discharge from NHP.
- Empirical information on the relationship between mercury concentration (µg/g) in suspended sediments entering NHP and the amount (mg/L) of these suspended sediments in the inflowing water.

- Historical (last nine years) information on activities near the buildings within the Y-12 Plant which were involved in past mercury losses, especially information regarding construction activities which could have temporally increased erosion of mercury-contaminated soil or fill material.

At this point our hypothesis is that mercury concentration in sediment washing into NHP increases during periods of especially high rainfall (low frequency, high-runoff-producing storms). Two such notable events have occurred in the Oak Ridge area since the last dredging of NHP, one in November 1973 (immediately following the last dredging) and one in April 1977 (midpoint in period since last dredging). Based on an analysis of discharge records for White Oak Creek (Edgar 1978), the November 1973 event (22.1 cm in 48 h) has a 25-year recurrence interval, whereas the April 1977 event (14.7 cm in 41 h) has a 2- to 3-year recurrence interval. Although the period since April 1977 has included some heavy rainfalls (maximum of 9.7 cm in 48 h in June 1978), none of these has been of the intensity and volume that characterized the November 1973 and April 1977 events. In fact, the past five years are generally regarded as "drought" years. Thus, one can speculate that the relatively constant mercury concentration in sediment layers in NHP down to about 25 cm may result from an absence of hydrologic extremes during the period represented by that part of the sediment column.

The above discussion of temporal trends should not detract from the observation that the concentration of mercury in surface sediments in NHP (and in EFPC immediately downstream, as discussed subsequently)

are greatly elevated (by a factor of 100 or more) over natural background values for soils and sediments. For example, Shacklette et al. (1971) give 0.147 µg/g as the average mercury concentration in uncontaminated soils and other surface materials from the eastern conterminous United States. In addition, Turner and Lindberg (1978) give river and lake sediment mercury values ranging from 0.14 to 20 µg/g, with the lower values for sediments deriving from areas known to be free of anthropogenic contamination and the higher values for sediments deriving from areas contaminated by mercury losses from a mercury cell chloralkali plant. Mercury levels in clayey surface sediments in Cherokee Lake have been reported (Turner and Lindberg 1978) to range from 0.6 to 2.5 µg/g.

Finally, it should be noted that coal pile runoff, which is apparently routed to NHP from the coal pile at the Y-12 steam plant, cannot explain the high mercury levels in NHP sediments. Coal burned in the Y-12 plant was sampled and analyzed for mercury along with other elements over an 11-month period (11 monthly composite samples) in 1975-76 (Lyon et al. 1978). Mercury concentrations in these coal samples averaged 0.18 µg/g, with a maximum observed value of 0.40 µg/g. Thus, coal dust washing into NHP could not account for the observed high mercury levels in NHP sediments.

3.1.2 East Fork Poplar Creek (EFPC) and Bear Creek (BC)

Data on contaminant concentrations in river sediment can be very difficult to interpret if samples have not been collected with a specific question in mind, or if supplemental information regarding other properties of the sediment is not available.

The spatial distribution of mercury in surface sediment of EFPC and BC was measured to answer two questions: Does the Y-12 Plant area appear to constitute a current (and continuing) source of sediment-bound mercury for EFPC and BC? and Is the longitudinal pattern of decrease in mercury concentration as a function of distance downstream from NHP similar for surface sediment and fish? Numerous studies have demonstrated an inverse relationship between mercury concentration in sediment and sediment particle size, i.e., fine-grained sediments (muds) exhibit higher concentrations than coarse-grained sediments (sand, gravel). In addition, among sediments with similar particle size distribution, those having higher organic matter concentration are typically also higher in mercury concentration. This preferential enrichment of mercury on smaller particles and on organic matter is thought to arise because of both surface area phenomena and the chemical affinity of mercury for organic matter.

Thus, valid comparison of the mercury concentration in sediments collected along the longitudinal axis of a stream, as was the goal in this study, requires that the samples collected be as similar as possible in particle size distribution and organic matter content. The situation for mercury in sediment is not unlike that for mercury in fish where fish weight/age is a covariate with mercury concentration. Valid comparisons among collection sites require either post-collection normalization of the data (see section on fish data) or collection procedures that target the same weight fish for collection at all sites (i.e., a weight-biased collection). For fish the latter procedure is often impractical. For sediment the best strategy is a combination of

biased collection procedures (i.e., collecting only fine-grained sediment) and post-collection size fractionation using sieving to restrict the particle size range of sediment submitted for analysis. Such a strategy was employed for sediment from East Fork Poplar Creek and Bear Creek (see Section 2.1.2.2). Because of time constraints and the limited amount of fine-grained sediment at several stations, we used a larger sieve size (0.125 mm) than is usually recommended (e.g., 0.044 or 0.063 mm) for this purpose. Although we cannot state with certainty that differences among collection sites due to particle size were completely eliminated, this component of the total variability was at least substantially reduced.

The organic matter content of the stream sediments submitted for mercury analysis could also vary among samples and thus could influence intersite comparisons. Again, limited time precluded analysis of the organic matter content of the samples and thus any effort to correct for this effect.

Before examining the data, one additional point should be made regarding our bias in sediment sampling and choice of sediment particle size range for analysis. To address the first of the two questions posed at the beginning of this subsection (Does the Y-12 Plant area appear to constitute a current and continuing source of sediment-bound mercury for EFPC and BC?), a sediment size fraction was selected that (1) is most subject to erosion, transport, and dispersion downstream of the plant area, and (2) is most likely to contain the highest concentration of mercury. Fine sand-sized (0.063- to 0.125-mm), silt-sized (0.004- to 0.063-mm), and clay-sized (< 0.004-mm) sediments

constitute the largest portion of the total bed sediment in a stream that is subject to continuous downstream transport. Coarser material (coarse sand, gravel) is transported only under relatively infrequent stormflow conditions. Thus an active point source of mercury-contaminated sediment is more likely to be located by analysis of fine-grained sediment collected along the axis of a stream than by analysis of either bulk sediments or the coarse fractions thereof.

To address the second question regarding a similar longitudinal pattern of decrease in mercury concentration as a function of distance downstream from New Hope Pond for surface sediment and fish, a sediment-size fraction was chosen that not only met the same criteria established for the first question but also considered the most likely pathway of fish exposure to mercury. Fine-grained sediment is the best candidate because (1) fish tend to preferentially ingest (passively or actively) fine-grained sediment in their feeding, and (2) prey organisms such as aquatic insects and snails are often in intimate contact with, or ingest, fine-grained sediment. Consequently, the accumulation of mercury by fish would not be expected to vary with the concentration of mercury in bulk sediment but rather with the mercury concentration in the sediment fractions to which they are directly and indirectly most exposed.

Mercury data for EFPC and BC sediments are given in Table 4 and for EFPC are displayed graphically as a function of distance downstream from New Hope Pond in Fig. 3. The EFPC data reveal a generally decreasing mercury concentration in < 0.125-mm sediment with increasing distance downstream from the pond (at RK 23.0). The highest

Table 4. Total mercury concentration in sediment (< 0.125-mm size fraction) for sampling sites in East Fork Poplar Creek, Bear Creek, and tributary creeks used as control sites

Station number	RK (RM)[a]	Total Hg (µg/g dry wt)
	East Fork Poplar Creek (EFPC)	
1	2.1 (1.3)	19
2	7.7 (4.8)	32
4	10.9 (6.8)	30
5	13.4 (8.3)	55
6	22.2 (13.8)	127
7	22.7 (14.1)	62,62[b]
8	22.8 (14.2)	90
	Bear Creek (BC)	
1	0.6 (0.4)	0.12
3	4.5 (2.8)	0.33, 0.48[b]
4	9.7 (6.0)	1.7
5	11.4 (7.1)	1.3
6	12.2 (7.6)	13
	Control (C)	
1	-	0.31
2	-	0.26, 0.29[b]

[a]River kilometer (river mile) relative to confluence with Poplar Creek for East Fork Poplar Creek and relative to confluence with East Fork Poplar Creek for Bear Creek.

[b]Duplicate analyses.

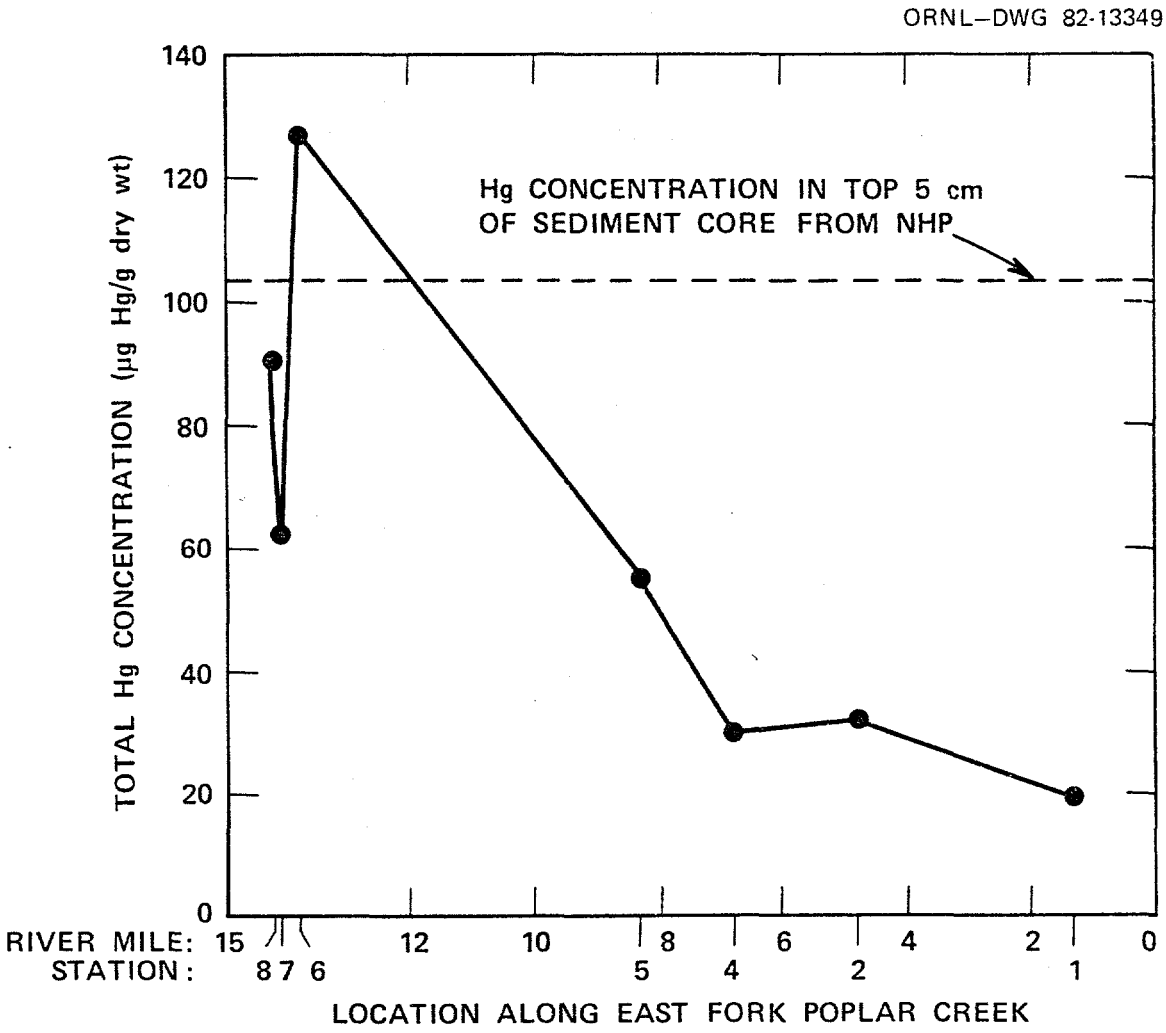

Fig. 3. Concentration of total mercury in sediment samples (< 0.125-mm size fraction) from East Fork Poplar Creek as a function of distance downstream from New Hope Pond (NHP).

exponential curve relationship:
$y = be^{mx}$
$m = 0.075$
$b = 16.65$
$R^2 = 0.86$

power curve relationship
$y = bx^m$
$m = 0.68$
$b = 9.31$

value (127 µg/g) at Station 6 may reflect a somewhat higher clay or organic matter content at this site than those at the upstream sites which were relatively devoid of any fine-grained sediment due to a higher flow velocity through the uppermost reaches of EFPC. The site at Station 6 was deliberately chosen for sampling because it was a more likely site for deposition of fine-grained sediment than the two sites immediately downstream of NHP. Not surprisingly, fine-grained sediments from all three of the upstream sites were similar in mercury concentration to the surface sediments in NHP. This observation suggests that NHP is the source of these downstream sediments.

The decrease in mercury concentration in sediment down the 23-km length of EFPC is consistent with the existence of a sustained source of mercury in the headwaters of EFPC and with downstream dilution by mixing with uncontaminated sediment. Losses of mercury from sediment by volatilization of elemental or methylmercury may also contribute to the downstream decrease, but this effect is likely to be minor compared with dilution by mixing with uncontaminated sediment.

As discussed for NHP, the mercury concentration in sediment from all sampling sites on EFPC exceeds natural background levels by factors of 60 or more. The control sample (C-1, Table 4) collected in a tributary to EFPC gives some indication of the local natural background level for mercury (0.31 µg/g) and further demonstrates that the high mercury levels in EFPC are not the result of a locally high natural background value for mercury in stream sediments.

In summary the EFPC sediment data support the hypotheses that mercury continues to be lost from the Y-12 Plant area, is not being

completely trapped by NHP, and is contaminating EFPC to its confluence with Poplar Creek. Mercury concentration in sediment at the most distant site tested (23 km downstream from NHP) is still greatly elevated over natural background levels and is similar to those in sediment from rivers, such as the North Fork of the Holston River (Hildebrand et al. 1980), which have been closed to fishing due to concentrations in the edible portion of fish that exceed the FDA action level.

The Bear Creek sediment survey (Table 4) revealed a relatively high total mercury concentration (13 μg/g) for the most upstream site (Station 6) located near the headwaters at the west end of the Y-12 Plant. However, all downstream sites, including Station 5 located only 0.8 km from the headwaters, yielded sediments with mercury concentrations only slightly above, or similar to, natural background. Mercury concentrations at Station 3 (the NPDES monitoring station) and Station 1 were similar to the concentration at the control site (C-2) in the Bear Creek Watershed (Table 4). These results indicate that inputs of mercury into Bear Creek are currently relatively low.

3.2 FISH

Previous studies have demonstrated a positive correlation between mercury content and the weight of fish, that is, larger fish tend to contain higher concentrations of mercury than do smaller fish because larger fish tend to be older and thus have had more time to accumulate mercury. The limited data collected for fish (except for bluegill collected at EFPC Station 8) tend to support this conclusion, although the correlation coefficient between mercury concentration and fish

weight was highly significant ($P \leq 0.01$) for only one sampling location (rock bass collected from BC Station 1). The correlation coefficients (r) between mercury concentration and weight of bluegill in EFPC were 0.05 ($P = 0.91$),[a] 0.67 ($P = 0.02$), 0.53 ($P = 0.09$), and 0.50 ($P = 0.12$) for EFPC Stations 8, 7, 5, and 1, respectively. For rock bass in Bear Creek (BC Station 1), the correlation coefficient between mercury concentration and fish weight was 0.88 ($P = 0.0001$). Thus, except for EFPC Station 8, from 25 to 77% (i.e., r^2) of the between-fish variation in mercury concentration in muscle of fish from a given sampling site can be accounted for by differences in fish weight.

The relatively low correlation coefficients for bluegill in EFPC are most likely a result of temporal variations in the rate of mercury uptake among fish of the same size and age. Contaminated sediments in EFPC provide the ultimate source of mercury to fish. As discussed previously, mercury concentrations associated with sediments vary longitudinally in EFPC (Fig. 3). Thus, as fish move upstream and downstream within this drainage, they are exposed to varying concentrations of mercury in their food, resulting in variations in the daily uptake rate of mercury. As a consequence, the correlation between mercury concentration in axial muscle and fish size (weight) will be partially obscured by the temporal variation in mercury uptake.

Because the weight distribution of fish collected was different between sampling sites (Table A.1), the mercury data were adjusted

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[a] P is the probability of obtaining a correlation coefficient as high as $r^2 = 0.05$, if the true correlation coefficient for the relation between mercury concentration and fish weight is 0.0.

(normalized) to account for the weight of the fish. Mercury values for EFPC Stations 7, 5, and 1, and for rock bass collected at BC Station 1, were normalized by adjusting them to the concentration in a 63-g fish using the respective regression equations of mercury concentration on fish weight calculated for each of the stations (Table 5). The length of a 63-g bluegill is approximately 16 cm, the minimum size that a sport fisherman is likely to keep for eating. Assuming there are no differences in growth rates of bluegill among the sampling locations, this normalization ensures that mercury levels in fish of approximately the same age and size are being compared among sampling locations. Results for bluegill in EFPC are shown in Fig. 4 and Table 5. The decreasing downstream trend is consistent with that observed for

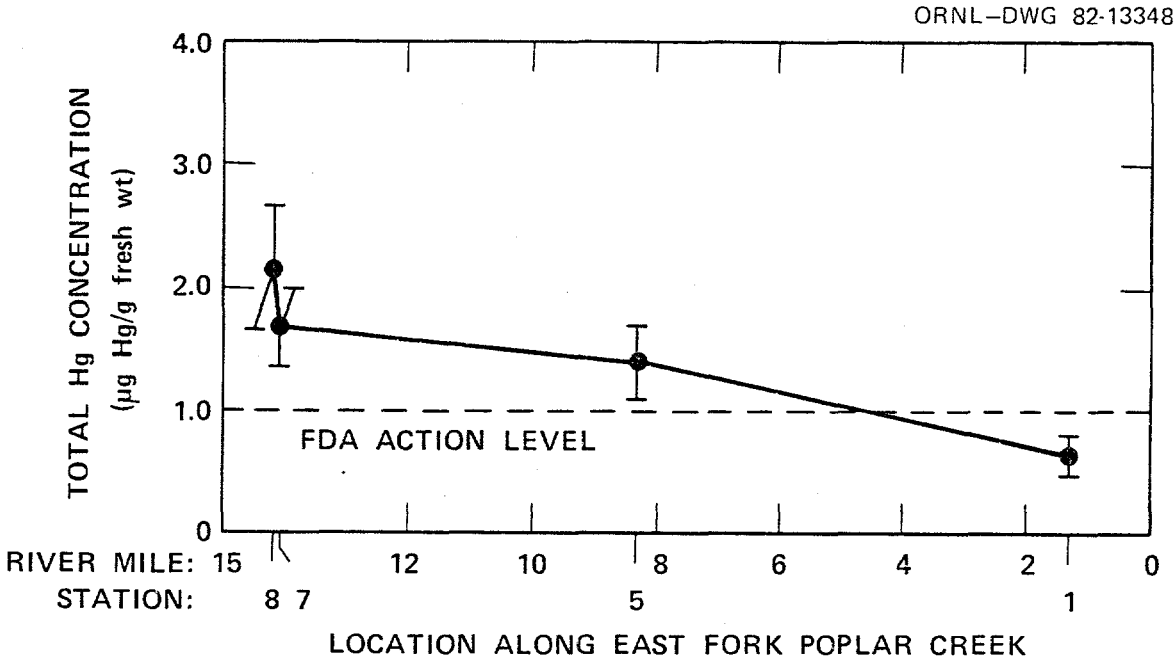

Fig. 4. Adjusted mean concentration of total mercury in samples of muscle from bluegills as a function of distance downstream from New Hope Pond (NHP). Error bars are ± 2 standard errors.

Table 5. Unadjusted and adjusted (normalized) mean concentration (± 2 SE) of total mercury in axial muscle of bluegill from East Fork Poplar Creek (ERPC) and Bear Creek (BC). Values in parentheses are the minimum and maximum concentrations. Mean concentrations for EFPC sampling stations 7, 5, and 1 were adjusted by normalizing to the average concentration of a 63-g bluegill using the regression equation of total mercury concentration on fish weight calculated from data for each sampling station

Stream-sampling station	Mean weight (g)	Total mercury concentration (µg/g, fresh wt)	
		Unadjusted mean	Adjusted mean
EFPC-8	62.7	2.13 ± 0.61 (1.70 - 3.60) n=7	--[a]
EFPC-7	61.1	1.56 ± 0.38 (0.66 - 2.5) n=11	1.66 ± 0.32[b]
EFPC-5	54.6	1.39 ± 0.31 (0.73 - 2.20) n=11	1.45 ± 0.26[c]
EFPC-1	32.5	0.56 ± 0.08 (0.32 - 0.72) n=11	0.66 ± 0.14[d]
BC-1	32.4	0.41 ± 0.22 (0.33 - 0.51) n=3	--

[a]Regression coefficient not significantly different from zero ($P > 0.90$).

[b]Total Hg concentration = 0.9180 + (0.0118) (fish weight in g); $r^2 = 0.45$.

[c]Total Hg concentration = 0.9824 + (0.0075) (fish weight in g); $r^2 = 0.28$.

[c]Total Hg concentration = 0.4418 + (0.0035) (fish weight in g); $r^2 = 0.25$.

sediment and moss and is consistent with our earlier suggestion of a sustained mercury source in the headwaters of EFPC.

Although samples of fish for background determination were not collected in this study, the extent of mercury contamination in bluegill in EFPC can be illustrated by comparison with mercury levels in bluegill collected in an earlier study from an area of Melton Hill Reservoir with no known mercury contamination (Elwood 1977). The average mercury concentration in the axial muscle of bluegill from Melton Hill Reservoir, determined by the same analytical method used here, was 0.05 µg/g. Mercury levels in the muscle of a 63-g bluegill from EFPC are thus at least an order of magnitude greater than the background levels in this species. More importantly, however, bluegill in the upper reaches of EFPC contain mercury levels that exceed the current "action level" for mercury in fish of 1.0 µg/g (Fig. 4) recommended by the U.S. Food and Drug Administration (FDA 1979). In fact, mercury concentration in 87% of all bluegill analyzed (and 100% of all bluegill analyzed weighing more than 40 g) from the three most upstream stations (EFPC Stations 5, 7, and 8) exceeded the FDA "action level" for mercury (Table A.1). Although none of the bluegill collected at the most downstream station in EFPC (Station 1) exceeded the action level, they all contained mercury concentrations in excess of the background concentration for bluegill in this area (Table A.1). One largemouth bass collected at EFPC Station 1 contained 1.3 µg/g of Hg, indicating that in the downstream reaches of EFPC (Station 1) some of the larger predatory species of fish do exceed the FDA "action level."

For Bear Creek (BC Station 1), only three bluegill were captured. Mercury concentrations did not exceed the FDA "action level," although all three specimens contained mercury concentrations in excess of the background concentrations for bluegill (Table 5). All of the bluegill collected from Bear Creek were small fish, weighing less than 40 g (Table A.1).

While no data exist on background concentrations of mercury in rock bass collected from this area, there is no reason to expect they would be substantially different from those for bluegill (i.e., approximately 0.05 µg/g). If this is the case, then rock bass in Bear Creek also are contaminated with mercury. With the exception of a single large rock bass, none of this species exceeded the FDA "action level" (Table A.1). It would be premature, however, to conclude that food chain contamination in Bear Creek is not a problem until additional fish from other sites further upstream are collected and analyzed.

Mercury concentrations in fish from contaminated environments have been shown to vary seasonally, with the annual maximum occurring in late spring-early summer and the annual minimum occurring in late fall-early winter (Tennessee Valley Authority 1972). Commonly the annual minimum is approximately half the annual maximum. If mercury concentrations in fish from East Fork Poplar Creek and Bear Creek exhibit a similar seasonal variation, then mercury concentrations for fish in Figure 4 and Tables 5 and A.1 are at or near their annual maximum and thus represent a "worst case" condition in terms of seasonal variation.

The correspondence between the spatial pattern of mercury in sediments of EFPC and in bluegill (Figs. 3 and 4) is consistent with the hypothesis that contaminated sediments are the primary source of mercury to aquatic organisms, including fish. The transfer of mercury from sediments to predatory fish, such as bluegill and rock bass, is mediated both through direct uptake of mercury associated with sediment particles that are ingested incidentally when feeding on organisms living in or on contaminated sediment, and through ingestion of prey species (e.g., aquatic invertebrates) that also accumulate mercury directly from sediment. Although direct uptake of methylmercury from water by fish has been demonstrated under experimental conditions (e.g., McKim et al. 1976), attempts to measure methylmercury in water from aquatic systems contaminated with mercury have been unsuccessful (Huckabee et al. 1979). While this does not preclude the possibility that direct uptake of methylmercury from water does occur in contaminated environments, it does suggest that it is a less important pathway than the food chain. The important point here is that wherever aquatic food chains are in contact with mercury-contaminated sediments, some of the mercury will be transferred to the organisms, resulting in elevated concentrations in aquatic biota.

Although all forms of mercury are toxic to aquatic organisms, the primary reason for concern about discharges of mercury into aquatic environments is the exposure of humans through ingestion of mercury contaminated fish. Most of man's exposure to mercury results from contamination of food. Of the total human intake of mercury from food, sources other than contaminated fish are generally insignificant. All

fish have a propensity to accumulate mercury in their tissues, including the axial muscle, the portion of fish tissue most often consumed by humans. It has been established that the form of mercury in the edible portion of fish muscle is almost completely methylmercury (MeHg), irrespective of whether the fish come from pristine environments (i.e., uncontaminated with anthropogenic sources of mercury) or from environments contaminated with inorganic or organic mercurials (Huckabee et al. 1979). While all forms of mercury are toxic, methylmercury is more toxic to humans than the other forms of organic and inorganic mercury.

Earlier work on mercury levels in fish collected in Poplar Creek demonstrated that most (> 90%) of the mercury in fish muscle was methylmercury (Elwood 1977). Thus, it is not unreasonable to expect that the majority of the mercury in bluegill and rock bass in EFPC and BC, respectively, is methylmercury. Although fish from these two streams are probably not an important source of protein for human populations in the Oak Ridge area, portions of both streams are accessible to the public for fishing. The consumption of mercury-contaminated fish caught from these waters thus cannot be precluded. Fish caught from these streams, therefore, do represent a potential source of human exposure to mercury.

At the present time, there is no major sport fishery on either East Fork Poplar Creek or Bear Creek. In the case of BC, the low fishing pressure, at least in the lower reaches where there are catchable populations of rock bass, bluegill, and largemouth bass, is most likely due to limited access to the stream. For EFPC, the low

fishing pressure is probably a result both of limited access, particularly in the upstream reaches, and of poor water quality and marginal fish habitat in the downstream reaches below the West End Sewage Treatment Plant located at river kilometer 12.9 (Fig. 1). Discharges of domestic sewage, containing both high chlorine concentrations and high biochemical oxygen demand, to EFPC from this overloaded treatment plant result in conditions that adversely affect the distribution and abundance of fish in EFPC. It is likely, for example, that during the warm, low-flow period in summer, oxygen depletion precludes the presence of fish in EFPC for some distance downstream of the sewage treatment plant. In addition, upstream movement of fish past the sewage plant may be restricted, if not prevented, by poor water quality in this area of EFPC, and thereby may also adversely affect fish populations in reaches of the stream above the sewage treatment plant.

Habitat suitable for spawning of fish and production of benthic organisms for fish food also is adversely affected by discharges from the sewage treatment plant. Sediments below the plant, for example, are predominantly organic matter discharged from the plant. These sediments are probably anaerobic for most of the year and thus are not used as spawning areas for fish. While some benthic organisms can tolerate anaerobic conditions, it is unlikely that fish exploit these organisms because of the poor quality of overlying water (e.g., low dissolved oxygen and high concentrations of hydrogen sulfide). The abundance and distribution of sport fish throughout EFPC thus may be adversely affected by the operation of the old sewage treatment plant on EFPC.

When the new sewage treatment plant now under construction on EFPC begins operation, and there is cessation of upstream disturbances in EFPC associated with the upgrading of the sewage collection system for this plant, it is anticipated that water quality and fish habitats in EFPC will substantially improve. When this occurs, populations of sport fish such as largemouth bass, bluegill, rock bass, and white bass should increase in EFPC. While we cannot predict the fishing pressure on EFPC when this occurs, it is likely that there will be an increase in sport fishing, particularly in the lower reaches of EFPC that are accessible by boat from the Clinch River and Poplar Creek.

3.3 MOSS AND LIVERWORT

Concentrations of total mercury in samples of moss collected at EFPC Stations 1, 2, and 6 indicate the same type of longitudinal profile as found for sediment and fish (Table 6). Mercury concentration at EFPC Station 6, 0.6 km downstream from New Hope Pond, is more than double that at Stations 2 and 1, approximately 15 and 21 km further downstream, respectively. Analytical results from both USGS and Y-12 indicate an appreciable decrease in concentration between Stations 1 and 2 for the moss samples collected by an ORNL employee on December 5, 1981 (Table 6). Such a decrease is not evident for the moss samples collected for this study on May 6, 1982.

Mercury concentration in moss in Bear Creek is appreciably lower than that in East Fork Poplar Creek (Table 6), just as it was for sediment and fish. At present no local control sample for moss is available. Results for EFPC Station 6 and also for BC Station 2

Table 6. Concentration of total mercury in samples of moss and liverwort collected at sites along East Fork Poplar Creek and Bear Creek

Site	Station number	RK (RM)[a]	Grid quadrant[b]	Species	Concentration of total mercury (µg Hg/g dry wt of plant)						
					Collected May 6, 1982					Collected Dec. 5, 1981	
					Replicate						
					1	2	3	Mean	Standard deviation	USGS[c]	Y-12[d]
East Fork Poplar Creek	1	2.1 (1.3)	C-6	Moss	16	15	12	14.3	2.1	4.0	7.1
	2	7.7 (4.8)	B-8	Moss	13	13	16	14.0	1.7	9.0	16
	6	22.2 (13.8)	D-14	Moss	38	30	34	34.0	4.0	30	41
				Liverwort	33,34[e]	36	36,39[e]	35.7	2.0	18	20
Bear Creek	2	3.2 (2.0)	D-7	Moss	0.68	0.44	0.45	0.52	0.14	-	-
				Liverwort	0.59	0.38	0.30	0.42	0.15	0.14	-

[a]River kilometers (river miles) upstream from the confluence of East Fork Poplar Creek with Poplar Creek or, for Bear Creek, river kilometers (river miles) upstream from the confluence of Bear Creek with East Fork Poplar Creek.

[b]From topographic map S-16A (1974) of the Oak Ridge area.

[c]Sample preparation and analyses done by the United States Geological Survey, Branch of Regional Geochemistry, Denver, Colorado.

[d]Sample preparation and analyses done by Y-12, Product Certification Division.

[e]Duplicate analyses.

indicate that mercury concentrations in moss and liverwort are quite similar, which is what would be expected.

Moss and liverwort are not part of any food chain leading to man, and therefore, the elevated concentration of mercury found in these bryophytes is not a direct health concern. The primary reason for sampling moss and liverwort was to evaluate the results obtained by the USGS Geochemistry Laboratory for the samples collected in December 1981 (see Section 2.6.3).

3.4 PASTURE GRASS

During seasons of heavy rains, East Fork Poplar Creek occasionally floods and subsequently deposits silt on portions of pasture lands. Since mercury occurs in creek sediments, deposition of silt provides a mechanism for mercury uptake by vegetation growing in the floodplain. Because a major concern in the floodplain is the potential for transfer of mercury in a pathway from vegetation to livestock to man in beef or milk, all samples were analyzed as received (i.e., fresh and unwashed).[a] A control area near X-10, not subject to flooding, was also sampled for comparison. Sample collections were partitioned into standing live foliage (1982 season) and dead foliage (1981 season). Live foliage represented only 2 to 4 weeks growth (a period without flooding), and dead foliage represented 8 months since senescence with

[a]Moss and liverwort samples collected on May 6, 1982, were washed because our objective was to copy the sample preparation and analytical procedures used by the USGS for the moss and liverwort samples collected by an ORNL employee on December 5, 1981. Pasture grass samples were not washed because our objective was to determine the concentration of mercury in the first biotic link of food chains leading to man, and cows ingest pasture grass in an unwashed condition.

Table 7. Total mercury concentration in live and dead foliage of pasture grass along East Fork Poplar Creek, May 1982

Station number	Distance[a] (m)	Live foliage n	Live foliage (Hg)[b]	Dead foliage n	Dead foliage (Hg)[b]
5	5	3	0.23 ± 0.12	3	4.43 ± 1.30
5	30	2[c]	0.18 ± 0.06	3	2.13 ± 0.66
5	100	3	NA[d]	3	0.37 ± 0.44
3	5	1[e]	0.11	3	6.97 ± 0.88
3	30	3	< 0.10	3	0.42 ± 0.26
3	100	3	NA	3	NA
Control	-	1[e]	0.10	3[c]	0.12 ± 0.02

[a]Distance from the edge of the creek.

[b]Mercury concentration (µg Hg/g fresh wt ± 2 SE).

[c]1 additional sample was < 0.10.

[d]NA = not analyzed.

[e]2 additional samples were < 0.10.

several events of high water. As shown in Table 7 and Table A.2, the concentrations in live and dead foliage from the control area are similar (approximately 0.1 µg Hg/g). This suggests that uptake from soils is not a major pathway for incorporation and that atmospheric deposition is insignificant because dead foliage was exposed much longer but contains approximately the same concentration of mercury as live foliage.

At EFPC Station 5 both live and dead foliage have elevated mercury concentrations. Concentrations for dead foliage are from 21 to 44 times

greater than for controls (Table 7), ranging from 2.1 µg/g at 30 m to 4.4 µg/g at 5 m from the edge of the creek. The concentration for dead foliage at 100 m (0.37 µg/g; area not subject to flooding) is slightly elevated over controls (0.12 µg/g) and probably represents transfer to dead foliage from grazing livestock. Live foliage (without flood events) contained only slightly elevated concentrations (0.23 and 0.18 µg/g at 5 and 30 m, respectively), thereby suggesting that the elevated concentrations of mercury on grass are primarily due to surface contamination from siltation. The samples of live foliage at the 100-m distance were not analyzed because live foliage at this distance is above the limit of flooding and would be expected to be similar to controls.

At Station 3, dead foliage (subjected to several flood events) collected 5 m from the edge of the creek had a concentration of mercury (6.97 µg/g) nearly 60 times greater than for the control sample (0.12 µg/g), decreasing to four times greater at 30-m distance (0.42 µg/g; Table 7). Concentrations for live foliage (without flood events) at 5 and 30 m were similar to concentrations for controls. No analyses were made of live foliage from Station 3 at 100 m for the same reason that none were made at Station 5. No analyses were made of dead foliage because of limitations on the number of analyses to be done and because one estimate at this distance was already available from Station 5. The concentration in dead foliage from 5 m at Station 3 (6.97 µg/g) is likely greater than that from 5 m at Station 5 (4.43 µg/g) because the floodplain at Station 3 is lower and narrower, and therefore is subject to more frequent inundation. The

higher concentrations for live foliage at Station 5 than at Station 3 are probably related to cattle grazing, which has not occurred at Station 3 since the autumn of 1981.

Hildebrand et al. (1980) found similar concentrations of mercury in fescue growing directly in the waste pond of an inactive chloralkali plant (5.2 µg/g in unwashed stems and 3.9 µg/g in washed stems). These concentrations are elevated by a factor of approximately 50 over world averages for other grass samples (US EPA 1975).

To assess the potential health hazard, the mercury concentrations in beef and milk were estimated using the stable element transfer coefficients and an elaboration of the Nuclear Regulatory Commission guidelines and equation (Eckerman and Young 1980). The concentration of total mercury in beef (C_B, µg/g) is estimated as

$$\begin{aligned} C_B = {} & k_{B,LF}\, C_{LF} k_{LF} k_1 k_2 A + \\ & k_{B,DF}\, C_{DF} k_{DF} k_1 k_2 A + \\ & k_{B,S}\, C_S k_S k_1 k_2 A \quad , \end{aligned} \tag{1}$$

where (starting with the right-hand-most variable and moving left for each of the three terms on the right side of the above equation)

A = daily weight of food ingested (kg/d),

k_2 = fraction of the average daily weight of food ingested that is pasture grass,

k_1 = fraction of the pasture-land area that is contaminated with mercury,

k_{LF} = fraction by weight of the pasture grass ingested by a cow that is live foliage,

k_{DF} = fraction by weight of the pasture grass ingested that is dead foliage,

k_S = fraction by weight of pasture grass ingested that is soil,

C_{LF} = concentration of total mercury in the live foliage component of the contaminated pasture grass ingested (µg/g),

C_{DF} = concentration of total mercury in the dead foliage component of the contaminated pasture grass ingested (µg/g),

C_S = concentration of total mercury in the soil component of the contaminated pasture grass ingested (µg/g),

$k_{B,LF}$ = transfer coefficient, i.e., fraction of the mercury in the live foliage component of the contaminated pasture grass ingested that is transferred to a kilogram of beef per day [1/(kg/d)],

$k_{B,DF}$ = transfer coefficient, i.e., fraction of the mercury in the dead foliage component of the contaminated pasture grass ingested that is transferred to a kilogram of beef per day [1/(kg/d)], and

$k_{B,S}$ = transfer coefficient, i.e., fraction of the mercury in the soil component of the contaminated pasture grass ingested that is transferred to a kilogram of beef per day [1/(kg/d)].

Note that $k_{LF} + k_{DF} + k_S = 1.0$, and the three variables C_{LF}, C_{DF}, and C_S for the concentration of mercury in the three components of pasture grass are on a per unit weight basis as eaten by the cattle (i.e., fresh weight). The concentration of total mercury in milk (C_M, µg/L) is calculated using a similar equation, except that the three coefficients for the transfer of mercury from ingested live foliage, dead foliage, and soil to beef are replaced by coefficients for the transfer of mercury from each of these three components to milk (fraction per liter of milk per day).

Estimates for the transfer coefficients for the three individual components are not available, so we assumed a common or average transfer coefficient denoted k_B [1/(kg/d)] and k_M [1/(L/d)] for beef and milk, respectively. Equation (1) for the concentration of total mercury in beef now may be written as

$$C_B = k_B k_1 k_2 A \, (k_{LF} C_{LF} + k_{DF} C_{DF} + k_S C_S) \quad . \qquad (2)$$

For each parameter in Eq. (2) we selected minimum, best estimate, and maximum values (Table 8). The footnotes for Table 8 indicate the bases for these estimates. Obviously, considerable professional judgment has been used; few of the values in Table 8 are based on direct measurement. Although it is possible to calculate C_B and C_M for all possible parameter combinations, we limited our analysis to the combinations involving all best estimates, all minimum estimates, and all maximum estimates.

The calculated concentrations for total mercury in milk are below the current FDA action level for mercury in fish muscle of 1.0 µg/g (FDA 1979), except in the most conservative case using maximum values for all the parameters (1.1 µg/g; Table 8). The calculated concentrations of total mercury in beef range from 0.002 µg/g (minimum) to 600 µg/g (maximum), with 1.6 µg/g as the best estimate. [The FDA has seen no need to establish an action level for mercury in either beef or milk (Betty Campbell, Food and Drug Administration, Guidelines and Compliance Branch, Bureau of Foods; personal communication with W. Van Winkle, June 22, 1982; FTS 8-245-3092)]. A more detailed uncertainty analysis is clearly possible, but at this time we feel it is unnecessary. There are 10 parameters in Eq. (2); considerable time and effort could be expended attempting to estimate the mean and a measure of variability for each of these parameters. In addition, there are several assumptions underlying the form of Eq. (2) which would be difficult to verify. Two examples are the assumption of a common transfer coefficient to beef from live foliage, dead foliage,

Table 8. Minimum, best, and maximum estimates, calculated using Eq. (2), of total mercury concentration in beef and milk from cattle grazing on contaminated pasture grass along East Fork Poplar Creek

Estimate	k_B[a] [l(kg/d)]	k_M[b] [l(L/d)]	k_1[c]	k_2[d]	A[e] (kg/d)	k_{LF}[f]	C_{LF}[g] (μg/g)	k_{DF}[h]	C_{DF}[i] (μg/g)	k_S[j]	C_S[k] (μg/g)	C_B (μg/g)	C_M (μg/ml)
Minimum	2.6×10^{-2}	4.7×10^{-5}	0.05	0.25	25	0.74	0.1	0.25	0.4	0.01	11	0.0023	4.2×10^{-6}
Best	2.6×10^{-1}	4.7×10^{-4}	0.1	0.5	50	0.48	0.2	0.48	3.5	0.02	32	1.57	0.0028
Maximum	2.6×10^{0}	4.7×10^{-3}	0.5	0.75	75	0.24	0.4	0.72	7.0	0.04	76	598	1.08

[a]Best estimate is the NRC guideline for transfer of mercury from ingested food to beef (Eckerman and Young 1980). Minimum is a factor of ten less than the best estimate. Maximum is a factor of ten greater than the best estimate.

[b]Best estimate is the coefficient for the transfer of mercury (in the methylmercury form) from ingested food to milk (Ng et al. 1968, Ng 1982). Minimum is a factor of ten less than the best estimate. Maximum is a factor of ten greater than the best estimate.

[c]Best estimate is based on examination of the elevation contours on the Oak Ridge Area map (S-16A, 1974) defining the extent of the floodplain. Minimum is 0.5 times the best estimate. Maximum is 5 times the best estimate and implies that the cow spends 50% of the time on the contaminated floodplain and/or that 50% of the pasture grass consumed comes from the floodplain portion of the pasture.

[d]Best estimate is based on professional judgment and assumes that the other 50% of the food is supplied by the farmer as hay from uncontaminated sources. Minimum is 0.5 times the best estimate. Maximum is 1.5 times the best estimate.

[e]Best estimate is the NRC generic guideline for daily weight of food ingested by a cow (Eckerman and Young 1980). Minimum is 0.5 times the best estimate. Maximum is 1.5 times the best estimate.

[f]Best estimate is based on professional judgment and implies that, after subtracting the fraction for the soil component (k_S), 50% of the remainder is live foliage and 50% is dead foliage. Minimum implies that 75% of the remainder is live foliage and 25% is dead foliage. Maximum implies that 25% of the remainder is live foliage and 75% is dead foliage.

[g]Best estimate is the average mercury concentration in live foliage at EFPC Station 5 at distances from the creek of 5 and 30 m (see Table 7). Minimum is the lowest concentration measured for live foliage from the floodplain (Station 3 at 30 m; see Table 7). Maximum is 2.0 times the best estimate.

[h]See footnote f.

[i]Best estimate is the average concentration in dead foliage at EFPC Stations 3 and 5 at distances from the creek of 5 and 30 m (see Table 7). Minimum is the lowest concentration measured for dead foliage from the floodplain (Station 3 at 30 m; see Table 7). Maximum is 2.0 times the best estimate.

[j]Best estimate is based on professional judgment and implies that a cow eats one kilogram of soil per day (i.e., $k_S A$ = 0.02 (50 kg/d) = 1.0 kg soil/d). Minimum is 0.5 times the best estimate. Maximum is 2.0 times the best estimate.

[k]The average mercury concentration measured in sediments from East Fork Poplar Creek at those stations near pasture land was 42.5 μg/g dry wt (average for Stations 4 and 5; see Table 2). C_S is defined on a per unit weight basis as eaten by the cow (i.e., fresh wt), and thus it was necessary to introduce an adjustment factor for fraction of moisture (f_M) to convert from dry weight to fresh weight. The conversion equation is C_S (fresh wt) = (1 - f_M) C_S (dry wt). For the best estimate, f_M = 0.25. Minimum is f_M = 0.50, and mercury concentration is 0.5 times the best estimate of 42.5 μg/g dry wt. Maximum is f_M = 0.10, and mercury concentration is 2.0 times the best estimate of 42.5 μg/g dry wt.

and soil and the lack of consideration of seasonal variation in any of the parameters, such as k_{LF} and k_{DF}.

In conclusion, although there is considerable uncertainty, the calculated best estimate for beef is greater than the FDA action level for mercury concentration in fish of 1.0 µg/g. Consequently, the issue of mercury contamination in beef from cattle grazing on contaminated pasture grass along EFPC needs further evaluation as a potential public health problem and public relations problem.

4. CONCLUSIONS AND RECOMMENDATIONS

4.1 CONCLUSIONS

4.1.1 Analytical Precision and Accuracy

1. Based on duplicate analyses, average coefficients of variation (a measure of precision) were approximately 10% or less for each of the four sample types.
2. Accuracy at mercury concentrations $\leq$ 1.1 µg/g was within 0.1 µg/g. Accuracy at higher concentrations requires further evaluation.

4.1.2 Sediment

1. Surface sediments in New Hope Pond (NHP) have high mercury concentrations ($\sim$ 100 µg/g dry wt) relative to expected natural background concentrations (< 1 µg/g dry wt).
2. Subsurface sediments in NHP have higher mercury concentrations (up to $\sim$ 300 µg/g dry wt) than surface sediments.
3. Based on the sedimentary record in NHP the mercury concentration in sediment washing into NHP has varied considerably, but appears to have decreased since the last major dredging of the pond. This conclusion is clouded by some uncertainties arising from the absence of any high runoff-producing storms during the past five years and needs further study to verify.
4. Mercury concentrations in fine-grained sediments (< 0.125-mm particle size) in East Fork Poplar Creek (EFPC) immediately below NHP are similar to those in surface sediments in NHP, suggesting an active and common source in the Y-12 Plant area.

5. Mercury concentration decreases in fine-grained sediments in EFPC with increasing distance from NHP, suggesting simple dilution of a point source of mercury located at, or upstream of, NHP.
6. Mercury concentration in all fine-grained EFPC sediments tested, including those collected 23 km (14 miles) downstream of NHP, exceeded natural background concentration by a factor of 60 or more.
7. The Y-12 Plant area does not appear to be a significant active source of mercury for Bear Creek sediments. Although mercury concentration in fine-grained sediment from the headwaters is elevated by a factor of approximately 40 over natural background concentration, downstream sediment contained essentially background concentration of mercury.

4.1.3 Fish

1. Data for bluegill and rock bass support the generalization of a positive correlation between mercury concentration and fish weight.
2. There is a decreasing downstream trend in mercury concentration in bluegill in EFPC that is consistent with the trend observed for sediments and that supports the conclusion of a sustained mercury source in the headwaters of EFPC.
3. Mercury levels in 87% of the bluegill collected in the upper reaches ($\geq$ RK 13) of EFPC exceed the FDA "action level" for mercury in the edible portion of fish of 1.0 µg/g fresh wt.

4. Mercury levels in bluegill and all but one rock bass collected in BC did not exceed the FDA "action level," although all specimens contained mercury concentrations in excess of background concentrations.
5. Contaminated sediments are the probable indirect source of mercury for the fish in EFPC and BC.
6. Based on earlier work, it is reasonable to expect that the majority of mercury in fish in EFPC and BC is in the methylmercury form, which is more chronically toxic to man than other forms of organic and inorganic mercury.
7. Human consumption of fish from EFPC containing more than 1.0 µg/g fresh wt mercury is likely, although the frequency and quantity of consumption are unknown.

4.1.4. Moss and Liverwort

1. There is a decreasing downstream trend in mercury concentration in moss in EFPC.
2. Mercury concentrations in moss from Bear Creek are appreciably lower than those in moss from EFPC.
3. Because moss and liverwort are not part of any food chain leading to man, the elevated mercury concentrations found in these plants are not a direct health concern.

4.1.5. Pasture Grass

1. Mercury concentration averages 3.5 µg/g fresh wt for dead foliage and 0.2 µg/g fresh wt for live foliage for pasture grass in the floodplain of EFPC.

2. Calculations indicate mercury concentration in milk from cows grazing along EFPC presents no health hazard.
3. Calculations indicate mercury concentration in beef from cattle grazing along EFPC may exceed 1.0 μg/g fresh wt.

4.2 RECOMMENDATIONS

4.2.1 Specific Actions

1. Consider the following actions to limit the quantity of mercury lost with sediments from the Y-12 Plant area:
   a. identify, decontaminate, and stabilize (or physically isolate) the area(s) yielding mercury-contaminated sediments to New Hope Pond; and
   b. design and implement future dredging plans for NHP to minimize sediment resuspension and loss to EFPC.
2. Consider the following actions in light of mercury concentrations found in fish in EFPC:
   a. notify the Tennessee Department of Public Health of the mercury contamination of fish in EFPC; and
   b. post DOE property at those locations along EFPC used by bank fishermen and boat fishermen.
3. Consider the following action in light of mercury concentrations calculated for beef from cattle grazing along EFPC: measure the concentration of mercury in hair from cattle or horses grazing along EFPC.

4.2.2 Further Monitoring

1. Evaluate both the analytical and total procedural accuracy of the Y-12 analytical method at mercury concentrations greater than 1.1 µg/g using blind reference standards.
2. Evaluate further the historical mercury record contained in New Hope Pond sediments by
   a. measuring mercury concentrations in sediment as a function of sediment load currently washing into New Hope Pond,
   b. obtaining and analyzing additional sediment cores, and
   c. establishing an absolute chronology of mercury deposition in the pond.
3. Monitor mercury concentration in sediments in EFPC every two years and in Bear Creek every five years.
4. Following the start of operation of the new West End Sewage Treatment Plant, monitor in EFPC
   a. mercury concentration in fish,
   b. abundance and size distribution of the dominant sport fish populations, and
   c. sport fishing effort and catch.

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APPENDIX A.1

RAW DATA FOR FISH AND PASTURE GRASS

Table A-1. Total mercury concentration in the axial muscle of fish from East Fork Poplar Creek (EFPC) and Bear Creek (BC). Locations of the sampling stations for each stream are given in Tables 1 and 2

Stream and station number	Species	Sex[a]	Weight (g)	Standard length (mm)	Total Hg concentration (µg Hg/g fresh wt)
EFPC-8	Bluegill	I	28.9	121	2.1
		I	34.1	125	1.8
		I	38.3	136	2.0
		F	55.7	146	1.7
		F	62.1	158	3.6
		M	85.3	168	1.8
		M	135.4	179	1.9
EFPC-7	Bluegill	I	19.8	105	0.69
		I	29.1	118	1.7
		I	31.2	120	1.7
		F	33.8	125	1.8
		F	36.3	126	0.66
		F	43.9	133	1.3
		F	63.9	158	1.2
		M	76.4	162	2.7
		M	85.3	159	1.5
		M	121.8	184	2.3
		M	130.1	182	2.3/2.7[b]
	Green sunfish	M	75.3	149	1.8
EFPC-5	Bluegill	I	8.5	72	1.2
		F	21.5	112	0.84
		I	24.6	112	0.73
		F	39.2	118	1.7
		M	41.7	125	1.4
		F	43.3	127	2.0
		F	61.2	137	1.1
		F	67.2	143	1.3
		F	87.4	152	1.7
		M	91.2	155	1.3/0.97[b]
		F	114.7	165	2.2
EFPC-1	Bluegill	ND	14.7	91	0.32
		ND	17.0	100	0.56
		ND	21.2	113	0.66
		ND	21.5	97	0.50
		ND	23.4	105	0.46
		ND	25.9	110	0.70
		F	37.5	121	0.45/0.52[b]
		ND	38.2	123	0.59
		ND	41.5	122	0.60
		ND	46.0	130	0.52
		M	70.7	140	0.72
	Largemouth bass	F	19.0	123	1.3
	White bass	I	24.4	146	0.15
		F	729.7	388	0.38/0.34[b]
	Rock bass	F	57.6	135	0.63
		M	82.1	154	0.87

Table A-1. (continued)

Stream and station number	Species	Sex[a]	Weight (g)	Standard length (mm)	Total Hg concentration (µg Hg/g fresh wt)
BC-1	Bluegill	M	30.3	121	0.33
		M	31.1	116	0.38
		M	35.7	121	0.51
	Rock bass	ND	29.5	116	0.25
		F	30.7	121	0.25
		F	39.5	125	0.33
		F	39.7	135	0.31
		F	53.5	141	0.27
		M	67.6	157	0.25
		M	80.1	160	0.26
		M	87.0	164	0.27/0.31[b]
		M	100.5	173	0.29
		F	108.9	180	0.62
		F	118.5	185	0.76/0.86[b]
		F	180.4	200	1.1/1.2
		M	177.8	205	0.83/0.74[b]
	Largemouth bass	F	154.2	218	0.62
		F	163.4	224	0.69

[a]I = immature, F = female, M = male, ND = not determined.

[b]Analyses of replicate muscle samples.

Table A-2. Total mercury concentration in mixed fescue (Festuca arundinacea) - blue-grass (Poa pratense) samples

Sample code	Station number	Distance[a] (m)	Component[b]	Concentration[c] (µg Hg/g fresh wt)
V-1	5	5	D	3.2
V-2	5	5	D	4.6
V-3	5	5	D	5.4
V-4	5	30	D	2.8
V-5	5	30	D	1.8
V-6	5	30	D	1.8
V-7	5	100	D	0.20
V-8	5	100	D	0.8
V-9	5	100	D	0.10
V-10	5	5	L	0.36
V-11	5	5	L	0.18
V-12	5	5	L	0.16
V-13	5	30	L	0.21
V-14	5	30	L	0.14
V-15	5	30	L	< 0.10
V-16	5	100	L	NA
V-17	5	100	L	NA
V-18	5	100	L	NA
V-19	3	5	D	6.3
V-20	3	5	D	7.8
V-21	3	5	D	6.8
V-22	3	30	D	0.68
V-23	3	30	D	0.29
V-24	3	30	D	0.29
V-25	3	100	D	NA
V-26	3	100	D	NA
V-27	3	100	D	NA
V-28	3	5	L	0.11
V-29	3	5	L	< 0.10
V-30	3	5	L	< 0.10
V-31	3	30	L	< 0.10
V-32	3	30	L	< 0.10
V-33	3	30	L	< 0.10
V-34	3	100	L	NA
V-35	3	100	L	NA
V-36	3	100	L	NA
V-37	NBS Orchard leaves		-	0.39[d]
V-38	NBS Orchard leaves		-	0.27[d]
V-39	NBS Pine Needles		-	0.15[d]
V-40	NBS Pine Needles		-	0.17[d]
V-41	Control		D	0.13
V-42	Control		D	< 0.10
V-43	Control		D	0.11[e]
V-44	Control		L	< 0.10
V-45	Control		L	0.10
V-46	Control		L	< 0.10

[a]Distance from the edge of the creek.

[b]D denotes dead foliage (1981 season); L denotes live foliage (1982 season).

[c]NA indentifies samples not analyzed.

[d]National Bureau of Standards certified values: orchard leaves 0.155 ± 0.015 and pine needles 0.15 ± 0.05.

[e]Two aliquots analyzed; concentrations reported per unit fresh weight of pasture-grass sample in the condition in which the dead foliage and live foliage were received at Y-12.

APPENDIX A.2.

FDA ACTION LEVEL FOR MERCURY IN FISH

APPENDIX A.2.

FDA ACTION LEVEL FOR MERCURY IN FISH

Reproduced on the following pages are the two sections from the Federal Register (1979) dealing with the action level for mercury in fish, shellfish, crustaceans, and other aquatic animals. It is included in this report to provide readily available documentation of the background and bases underlying the current action level of 1.0 ppm (µg/g fresh wt) and the change from 0.5 ppm (µg/g fresh wt).

Science, and Transportation of the Senate and the Committee on Interstate and Foreign Commerce of the House of Representatives disapprove any further extensions, by committee resolution.

On June 15, 1978, GSA specification HH-I-515D became effective. This specification contains requirements for the flame resistance and corrosiveness of cellulose insulation that supersede the flame resistance and corrosiveness provisions of HH-I-515C. Therefore, the Commission would have been required to publish the proposed amendment to the interim standard by August 24, 1978, unless the Commission extended this period. On August 8, 1978, the Commission extended this period for 150 days, until January 22, 1979 (43 FR 35238).

The Commission believes that it is necessary to further extend the period of time for proposing the flame resistance and corrosiveness requirements of HH-I-515D as an amendment to the interim standard in order to study the technical and scientific basis and the safety and economic consequences of these requirements. This further extension is for 45 days, from January 22, 1979 until March 8, 1979.

Pub. L. 95-319 provides that the Commission shall issue an amendment to the interim standard unless the Commission determines, after considering public comments, that the amendment is not necessary to protect consumers from the unreasonable risk of injury associated with flammable or corrosive cellulose insulation, or unless the Commission determines that implementation of the amendment will create an undue burden on persons subject to the interim standard. Therefore, the Commission is required to consider these issues.

The additional time is necessary for the Commission to evaluate comments from interested persons that raise technical and economic issues concerning the proposed amendment. The Commission received these comments in response to a notice of intent to propose an amendment, which the Commission published in the FEDERAL REGISTER on September 6, 1978 (43 FR 39720). The additional time is also necessary for the Commission to consider technical and economic evaluations of the proposed amendment that the National Bureau of Standards and a contractor prepared for the Commission and made available to the Commission staff in December 1978. The Commission will also use the additional time to review the proposed amendment for technical accuracy and make editorial and other changes necessary to insure that the document is suitable for publication in the FEDERAL REGISTER.

The Commission does not anticipate that any further extension will be necessary for preparing the proposed amendment. If the Commission is able to complete its work before March 8, 1979, the Commission will publish the proposal at an earlier date.

Therefore, in accordance with section 35(c)(2)(D)(i) of the act, as amended by Pub. L. 95-319, the Commission extends by 45 days, from January 22, 1979 until March 8, 1979, the time in which it must publish the flame resistance and corrosiveness requirements of GSA Specification HH-I-515D as a proposed amendment to the interim standard for cellulose insulation at 16 CFR Part 1209. In accordance with Pub. L. 95-319, this period may be further extended.

Dated: January 16, 1979.

SADYE E. DUNN,
Secretary, Consumer Product Safety Commission.

[FR Doc. 2040 Filed 1-18-79, 8:45 am]

[4110-03-M]

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

Food and Drug Administration

[21 CFR Part 109]

[Docket No. 77N-0166]

ACTION LEVEL FOR MERCURY IN FISH, SHELLFISH, CRUSTACEANS, AND OTHER AQUATIC ANIMALS

Withdrawal of Proposed Rulemaking and Termination of Rulemaking Proceeding

AGENCY: Food and Drug Administration.

ACTION: Withdrawal of proposal.

SUMMARY: This document withdraws a proposed rulemaking and terminates a rulemaking proceeding to codify the existing action level limiting the amount of unavoidable mercury residues permitted in fish and shellfish. Instead of establishing the action levels by a formal regulation, the Food and Drug Administration (FDA) will continue to use an administrative action level to regulate those mercury residues. Elsewhere in this issue of the FEDERAL REGISTER is a notice announcing the availability of that action level.

FOR FURTHER INFORMATION CONTACT:

Howard N. Pippin, Bureau of Foods (HFF-312), Food and Drug Administration, Department of Health, Education, and Welfare, 200 C St. SW., Washington, DC 20204, 202-245-3092.

SUPPLEMENTARY INFORMATION: In the FEDERAL REGISTER of December 6, 1974 (39 FR 42738), the Commissioner of Food and Drugs proposed to adopt, in former Part 122 (21 CFR Part 122) (recodified as Part 109 (21 CFR Part 109) in the FEDERAL REGISTER of March 15, 1977 (42 FR 14032)), an action level of 0.5 part per million for unavoidable residues of mercury in the edible portion of fish and shellfish.

In the same issue of the FEDERAL REGISTER, the Commissioner proposed to establish procedural regulations regarding poisonous and deleterious substances in food (39 FR 42743). That proposal included procedures and criteria for establishing tolerances under section 406 of the Federal Food, Drug, and Cosmetic Act (21 U.S.C. 346) for unavoidable poisonous or deleterious substances in food. It also included provisions for establishing "action levels," through informal, i.e., notice and comment, rulemaking.

The procedural regulations that were finally promulgated, however, differed from those proposed. As discussed in the preamble to the final order published in the FEDERAL REGISTER of September 30, 1977 (42 FR 52814), the Commissioner decided that a simpler procedure than that proposed for establishing action levels is appropriate. This simplified procedure, set forth in § 109.4(b) (21 CFR 109.4(b)), provides for FDA to set an action level administratively and to publish a notice of availability of the action level and the information on which the agency relied in setting the action level. The supporting information is placed on file with the Hearing Clerk, FDA, and the notice invites public comments on the action level.

Because FDA expects to continue to receive new information bearing on the appropriate limit for mercury in fish and other aquatic animals, it is appropriate to continue to regulate the mercury levels in fish and shellfish through an action level, rather than a formal tolerance. The Commissioner is therefore terminating the December 6, 1974, proposal to codify the action level for mercury in fish and shellfish and, in accordance with the procedure in § 109.4(b), is announcing the availability of the revised action level for mercury in fish and shellfish.

RECEIVED COMMENTS

The agency received 71 comments in response to the December 6, 1974 proposal. Although most of the comments have been rendered moot due to the withdrawal of the proposal, the Commissioner has decided to respond to them because many of them reflect a lack of understanding of FDA's current procedures regarding action levels for mercury in fish. Also, some information received bears on the still relevant issue of what the action level should be. Based on current information, the Commissioner has deter-

mined that the action level should be changed from 0.5 part per million (ppm) mercury to 1.0 ppm.

1. Two comments objected to the Commissioner's interpretation of "added" in applying the principles of section 406 of the act. Both comments pointed out that because mercury occurs naturally in some of the waters inhabited by fish, particularly marine fish, and is not introduced to these waters by some activity of man, resulting mercury residues in the fish are naturally occurring and not "added."

The Commissioner notes that these issues were also raised by the comments received in response to the proposal regarding general principles for the establishment of tolerances for added poisonous or deleterious substances in food. In the preamble to the September 30, 1977 final rule establishing the procedures for regulating food contaminants and naturally occurring poisonous or deleterious substances, the Commissioner discussed in detail the issue of added versus naturally occurring substances, with specific reference to mercury in fish. The Commissioner concluded that under the act the test for determining whether a substance is "added" or natural is whether it is necessarily an inherent part of the food, in which case it is natural. Otherwise it is "added" under the law.

This issue has been raised in a pending case involving mercury in fish (*Anderson Seafoods, Inc.* v. *Califano et al.*, No. 78-1962 (5th Cir. 1978)). In that case, the district court rejected FDA's definition of "added" and held that to be "added" within the meaning of section 402(a)(1) of the act (21 U.S.C. 342(a)(1)), the substance must be present in food as a result of human action (*United States* v. *Anderson Seafoods, Inc.*, 447 F. Supp. 1151 (N.D. Fla. 1978)). The district court also held, however, that some part of the mercury in swordfish, although not quantifiable, was due to human intervention. Thus, even under the district court's test, mercury in swordfish would be treated as an added poisonous or deleterious substance under section 402(a)(1) of the act.

As noted above, this issue is currently pending before the United States Court of Appeals for the Fifth Circuit in the appeal of the district court's decision in *Anderson Seafoods*. Pending a final resolution of this issue, the Commissioner intends to adhere to the definition of "added" found in § 109.3(d) of the agency's regulations (21 CFR 109.3(d)).

2. One comment stated that in view of the lack of adequate definitive information regarding mercury residues in fish, and action level should be set for a limited period, with automatic expiration in 1 or 2 years, so that reexamination of accumulated data would be automatic and that action level could be revised according to the most current data.

The Commissioner considers this provision unnecessary. The Food and Drug Administration will continue to monitor mercury residues in fish, shellfish, and other aquatic animals and will continue to evaluate any data regarding methylmercury in fish that become available, so that the action level can be reevaluated and revised as necessary. As with any other action level, the time for any such reevaluation must be based on the availability of scientific information rather than on an absolute calendar-year interval.

3. One comment requested that the definition of a "lot" of fish be revised to reflect current fishery practices. Specific changes requested were that a boatload of fish should be allowed to constitute a lot and that the fish in a lot should be allowed to range considerably in size. Another comment requested that the provision that fish constituting a lot be from "similar waters" be changed to "the same waters." The comment stated that in a locale where there are several lakes constituting "similar waters," one lake may be polluted and contain contaminated fish, while another nearby lake may not.

The Commissioner advises that because the proposed regulation for mercury in fish and shellfish is being withdrawn, there will not be a definition of "lot" specifically directed to fish sampled for mercury residues. Instead, in enforcing the action level, FDA will use its traditional definitions and interpretations of "lot," which appear in several places in the regulations (e.g., § 101.9(e) (21 CFR 101.9(e))) and in agency documents such as the Inspector Operations Manual sample collection instructions for unprocessed fish, e.g., imported whitefish, which include the following definition:

> A lot is defined as follows: "Each group of fish of a distinct size, listed in the invoice as from a distinct lake, will be considered as a separate lot. Where an invoice does not list the lakes or origin of boxes of fish in a shipment, fish of the same size and kind will be considered to comprise a *single lot.* When the size of fish or lakes or origin in a shipment are not specified, the shipment will be treated as a single lot."

This definition is an example of how FDA defines a "lot" based on the manner in which the food is shipped (invoiced) in interstate commerce. In the case of a boatload of fish, if the fish are invoiced for sale without any classification other than the entire contents of the boat, then the entire amount of fish would constitute a single lot. If the fish sold from that boat are classified by size and/or by waters of origin, or any other more specific classification, however, than each group of fish so classified would constitute a separate lot.

Regarding the use of "similar waters" rather than "the same waters," the Commissioner points out that "similar waters" applies to open waters, i.e., similar areas in one body of water, either at sea or in a very large lake. When the water-of-origin information is available, fish from different lakes constitute separate lots.

4. Some comments contended that regulation of mercury residues in fish should be based on the amount of methylmercury present rather than total mercury, because methylmercury is the compound of toxicological concern. One comment stated that only about half of the mercury in American fish is in the form of methylmercury.

The Commissioner does not agree with the contention that only half of the total mercury in fish is methylmercury. The limited data obtained to date indicate that mercury residues in most fish and other aquatic animals are 80 percent or more methylmercury. The Commissioner agrees, however, that it may be more appropriate to use methylmercury levels to regulate these mercury residues. The agency is currently developing an analytical method that may be adequate for determining methylmercury for enforcement purposes. If such a method is developed, the Commissioner will revise the action level to a methylmercury basis.

Toxicological Reevaluation

A number of the comments requested that the Commissioner reevaluate the proposed 0.5 ppm action level. Several stated that the Commissioner had not considered all the available information in making the toxicological evaluation of mercury residues in fish and that this information does not support an action level as low as 0.5 ppm. Among the information provided in some of these comments were reports of a protective effect against methylmercury toxicity provided by the selenium that occurs in marine fish and studies of certain populations who ingested large amounts of fish containing methylmercury and who did not exhibit symptoms of mercury poisoning.

At the time of the proposal, the Commissioner was aware of some studies suggesting a protective effect of selenium against methylmercury toxicity but considered the available data inconclusive. Since 1974, other information on the selenium/methylmercury relationship has become available. A workshop was jointly sponsored by FDA and the National Marine Fisheries Service in 1977 to review recent research on the effects of selenium on methylmercury toxicity (a copy of the

report of the workshop is on file in the office of the Hearing Clerk, FDA). Participants had hoped to reach a consensus as to the extent that the presence of selenium in fish should be taken into account in reassessing the guideline for mercury. Although much work has been done in the area of mercury/selenium relationships and there appears to be some mechanism in fish for protection against methylmercury toxicity in animals, whether or not selenium is protective is not clear. The participants in the workshop concluded that the findings to date are inconclusive.

The Commissioner advises that at the time of the proposal, the estimate of tolerable weekly or daily intakes of methylmercury was based on information developed primarily by Swedish studies of Japanese individuals poisoned in the episode of Niigata, which resulted from consumption of contaminated fish and shellfish. Data on mercury levels in blood and hair, and in some cases the brains of poisoned patients, provided a basis for establishing methylmercury levels at which toxic effects were observed. The blood level at the time of onset of symptoms was estimated by extrapolation and it was concluded that the lowest blood level for the appearance of signs and symptoms of methylmercury poisoning was 200 parts per billion (ppb) (0.2 ppm). Biochemical studies in Finland and Sweden on the movement of methylmercury through the human system made it possible to relate blood levels to daily intake. Using trace amounts of radiolabled methylmercury, it was shown that methylmercury is completely absorbed from food and is distributed rapidly throughout the body and that its estimated average biological half-life is about 70 days. This information was used to show the theroretical total body burden of mercury as a function of time when a constant dose of methylmercury is ingested. This calculated body burden becomes essentially steady after about a year. In this steady state the total amount of methylmercury in the body is proportional to the daily intake. This result was confirmed by studies on Swedish fishermen having relatively high daily intakes of methylmercury.

From these data and using these calculations it was estimated that a blood level of 200 ppb would be reached with a minimum daily intake of approximately 300 micrograms (μg) of mercury, present as methylmercury in the diet. In setting intake standards for a whole population it is usual to apply a safety factor. In cases where human data are available the safety factor used is 10. Thus a maximum tolerable level would be 20 ppb of methylmercury daily in the blood, or 30 μg methylmercury daily in the diet.

The following limitations to this approach were recognized: (1) it was not known to what extent particular individuals are more or less sensitive to mercury than others; (2) the estimates were based on the "lowest level that caused an effect" rather than the normal procedure of using a "no effect dose level"; (3) questions about dose/response relationships in human fetuses and newborn infants were unanswered; and (4) there is a possibility of subclinical effects arising from exposure to very low levels of methylmercury.

Since the 0.5 ppm action level was proposed, there have been further studies of individuals exposed to methylmercury as a result of the poisoning episode in Iraq in 1972, in which homemade bread prepared from seed wheat treated with a methylmercurial fungicide was consumed. There are also reports on populations ingesting large amounts of fish that show that many individuals have blood mercury levels that clearly exceed the allowable limit and appear to be asymptomatic. The Iraqi studies contained indications that toxic effects were associated with a total intake of methylmercury in the range of 40 to 60 milligrams (mg) for a 70-kilogram (kg) man or with blood levels of 400 to 600 ppb.

These data would appear to suggest that the values used in 1974 for estimating a tolerable level of methylmercury for humans may have been too low. Additional data developed on the biological half-life of methylmercury in humans, however, indicate a need to take into account the problem of variations among individuals. In the Iraqi episode, 90 percent of the individuals studied had a biological half-life of methylmercury of 35 to 100 days and 10 percent showed values of 110 to 120 days. Individuals having a long biological half-life would accumulate much higher steady state levels than those having short biological half-lives and would thus be at greater risk from the same level of methylmercury intake.

In addition, information has been developed on the so-called "late onset of symptoms" associated with methylmercury poisoning. Specifically, by 1973, in the Agano area of Niigata, Japan, new cases of methylmercury poisoning were detected years after the consumption of contaminated fish had ceased. This finding indicates that there may be some damage which is not diagnosed under current procedures, and it introduces further uncertainty into the determination of the "lowest effect level" used to estimate tolerable intakes.

Therefore, the Commissioner concludes that, in spite of the contention of some of the comments, there are substantial uncertainties and variations in the total body of information on methylmercury toxicity form long-term chronic exposure. In light of these uncertainties and variations, the data cannot be considered as supporting a change in the estimated tolerable intake of methylmercury.

Seafood Consumption Reevaluation

The Commissioner has recently received new data on the consumption of fish in the United States, particularly those species of dietary significance known to contain mercury residues. The new data present more comprehensive and detailed information on fish consumption than has been available previously (Report on the Chance of U. S. Seafood Consumers Exceeding the Current Acceptable Daily Intake for Mercury and Recommended Regulatory Controls, National Marine Fisheries Service, February 8, 1978). In this report, the National Marine Fisheries Service (NMFS) concluded that the 0.5 ppm guideline is unnecessarily restrictive and recommended an action level of 1.0 ppm mercury for swordfish and freshwater fish and no action level for marine species other than swordfish. The NMFS concluded that a 1.0 ppm action level would protect consumers as much as does the 0.5 ppm level. also, the higher level would provide a significant economic benefit to those industries most seriously affected by regulatory actions under the 0.5 ppm guideline and would enhance the future development of a number of presently underutilized fisheries. The report also stated that the less restrictive regulatory approach it recommended would significantly increase consumer confidence in seafood. Accompanying NMFS's recommendations for a less restrictive regulatory level was a recommendation that monitoring of mercury levels in fish and other seafoods and consumption patterns of fishery products in the United States be continued.

The NMFS consumption study report has been carefully studied, and the Commissioner concludes that the probability of systematic exposure to a substantial intake of methylmercury by the average consumer appears to be lower than FDA had originally estimated when it set the 0.5 ppm guideline. Among other considerations, the new data make it possible to estimate probable methylmercury intakes bases on mercury levels in individual species of fish and other aquatic animals. When the 0.5 ppm level was reevaluated in 1974, the limitations in the available data required that maximum projected residues be applied to all species. This resulted in a higher estimated probable intake.

The Commissioner agrees with NMFS's conclusion that a 1.0 ppm reg-

ulatory level for swordfish and freshwater fish would provide adequate protection to consumers. Because completely abandoning a regulatory level for marine species other than swordfish may result in increased concentrations of mercury in some species as marketed, the Commissioner concludes that a regulatory level applicable to all species should be retained. Based on the NMFS's data on consumption rates, mercury residue levels, and individualized allowable daily intakes (ADI's) a 1.0 ppm regulatory level for marine species should provide adequate protection against significant numbers of consumers exceeding their ADI's.

Accordingly, the Commissioner concludes that 1.0 ppm is the appropriate level at which to regulate residues of mercury in fish and other aquatic animals. Elsewhere in this issue of the FEDERAL REGISTER, the Commissioner announces the availability of, and invites comments on, the Administrative Guideline establishing the action level of 1.0 ppm mercury in fish, shellfish, crustaceans, and other aquatic animals. The Administrative Guideline and underlying information supporting it are available for public examination in the office of the Hearing Clerk (HFA-305), Food and Drug Administration, Rm. 4-65, 5600 Fishers Lane, Rockville, MD 20857.

The Administrative Guideline (No. 7408.09) establishing the action level provides the following instructions to FDA District Offices: "Recommend legal action to Division of Regulatory Guidance where the composite of fish or shellfish analyzed by the procedure outlined in the Twelfth Edition of the Official Methods of Analysis of the Association of Official Analytical Chemists 25.103-25.107 shows:

Mercury (Hg) ..... 1.0 ppm (edible portion only)

NOTE.—Recommendations for legal action must clearly indicate the exact portion of the food used for analysis. The portion used for analysis must be prepared by the appropriate procedure outlined in Volume 1 of the Pesticide analytical Manual, sections 141.12 and 141.22.

The Food and Drug Administration will continue to monitor mercury levels in fish so that if there is any change in mercury residue levels as a result of raising the action level, or if there is any other change in the information regarding mercury in fish, the action level can be revised accordingly.

This notice of withdrawal and termination of rulemaking proceeding is issued under the Federal Food, Drug, and Cosmetic Act (secs. 306, 402, 406, 701(a), 52 Stat. 1045-1046 as amended, 1049, 1055 (21 U.S.C. 336, 342, 346, 371(a))) and under authority delegated to the Commissioner (21 CFR 5.1).

Dated: January 8, 1979.

DONALD KENNEDY,
Commissioner of Food and Drugs.

[FR Doc. 79-1810 Filed 1-18-79; 8:45 am]

[4110-03-M]

[21 CFR Parts 175 and 189]

[Docket No. 78N-0112]

2-NITROPROPANE

Proposed Removal From Food Additive Use

AGENCY: Food and Drug Administration.

ACTION: Extension of comment period for proposed rule.

SUMMARY: This document extends the comment period on the proposal to delete from the food additive regulations provisions for use of 2-nitropropane as a component of adhesives intended to contact food and to list it as a substance prohibited from addition to human food. The Commissioner of Food and Drugs, having evaluated available data, has concluded that 2-nitropropane is a carcinogen in test animals.

DATE: Written comments by April 2, 1979.

ADDRESS: Written comments to the Hearing Clerk (HFA-305), Food and Drug Administration, Rm. 4-65, 5600 Fishers Lane, Rockville, MD 20857.

FOR FURTHER INFORMATION CONTACT:

John J. McAuliffe, Bureau of Foods (HFF-334), Food and Drug Administration, Department of Health, Education, and Welfare, 200 C St. SW., Washington, DC 20204, 202-472-5690.

SUPPLEMENTARY INFORMATION: In the FEDERAL REGISTER of December 1, 1978 (43 FR 56247), the Commissioner proposed to amend § 175.105 *Adhesives* (21 CFR 175.105) by deleting the use of 2-nitropropane currently permitted in this section, and to amend Part 189—Substances Prohibited from Use in Human Food (21 CFR Part 189) by adding new § 189.310 *Nitropropane.* These actions were taken by the Commissioner after evaluating the available data and concluding that the report by the Department of Health, Education, and Welfare/National Institute for Occupational Safety and Health (HEW/NIOSH) demonstrates that 2-nitropropane is a carcinogen in test animals and that the continued use of 2-nitropropane as a food additive is no longer warranted. Interested persons were requested to submit their comments on the proposal on or before January 2, 1979.

The Commissioner has received requests for extension of time for comment from the law firm of Covington and Burling on behalf of International Minerals and Chemical Corp. (IMC) and the law firm of Keller and Heckman on behalf of Durkee Foods, Division of SCM Corporation. The request for IMC sought an extension of time to prepare a written report on the most recent toxicology testing on 2-nitropropane, a risk assessment, and a regulatory analysis in response to the December 1 proposal. IMC has also made freedom of information requests to FDA and NIOSH in support of its request for extension. Further information on the availability of the material is expected to be indicated in the NIOSH response to the IMC request for information.

The Commissioner is extending the comment period to close of business April 2, 1979. The extension will permit consideration of the disposition of the request for background material and an opportunity for comments on any material that becomes available. Requests for access to the background material may be made to NIOSH.

Therefore, under the Federal Food, Drug, and Cosmetic Act (secs. 201(s), 402, 409, 701, 52 Stat. 1046-1047 as amended, 1055-1056 as amended, 72 Stat. 1784-1788 as amended (21 U.S.C. 321(s), 342, 348, 371)) and under authority delegated to the Commissioner (21 CFR 5.1), the comment period on the December 1, 1978 proposal to remove 2-nitropropane from food additive use (43 FR 56248) is extended to April 2, 1979.

Interested persons may, on or before April 2, 1979 submit to the Hearing Clerk (HFA-305), Food and Drug Administration, Rm. 4-65, 5600 Fishers Lane, Rockville, MD 20857, written comments regarding the proposal. Four copies of all comments shall be submitted, except that individuals may submit single copies of comments, and shall be identified with the Hearing Clerk docket number found in brackets in the heading of this document. Received comments may be seen in the above office between 9 a.m. and 4 p.m., Monday through Friday.

Dated: January 15, 1979.

WILLIAM F. RANDOLPH,
Acting Associate Commissioner for Regulatory Affairs.

[FR Doc. 79-1902 Filed 1-18-79; 11:34 am]

Board of Governors of the Federal Reserve System, January 15, 1979.

GRIFFITH L. GARWOOD,
Deputy Secretary of the Board.

[FR Doc. 79-1900 Filed 1-18-79; 8:45 am]

[4110-03-M]

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

Food and Drug Administration

[Docket No. 77N-0166]

ACTION LEVEL FOR MERCURY IN FISH, SHELLFISH, CRUSTACEANS, AND OTHER AQUATIC ANIMALS

Availability of Revised Action Level

AGENCY: Food and Drug Administration.

ACTION: Notice.

SUMMARY: The Food and Drug Administration (FDA) announces the availability of an Administrative Guideline that establishes a new action level for mercury in fish and shellfish.

ADDRESSES: Single copies of the action level are available from, and written comments on the guideline may be submitted to, the office of the Hearing Clerk (HFA-305), Food and Drug Administration, Rm. 4-65, 5600 Fishers Lane, Rockville, MD 20857.

FOR FURTHER INFORMATION CONTACT:

Howard N. Pippin, Bureau of Foods (HFF-312), Food and Drug Administration, Department of Health, Education, and Welfare, 200 C St., SW., Washington, D.C. 20204, 202-245-3092.

SUPPLEMENTARY INFORMATION: Elsewhere in this issue of the FEDERAL REGISTER, the Commissioner of Food and Drugs withdraws proposed rulemaking and terminates a rulemaking proceeding that would have codified the existing action level that limits to 0.5 part per million (ppm) unavoidable residues of mercury in the edible portion of fish and shellfish. Instead of establishing a formal regulation, FDA will continue to use an administrative action level to regulate such mercury residues.

The Commissioner is therefore announcing the availability of Administrative Guideline No. 7408.09 establishing the action level of 1.0 ppm mercury in fish, shellfish, crustaceans, and other aquatic animals. The rationale for establishing this action level is discussed in the withdrawal and termination document referred to above. The Administrative Guideline establishing the action level is available for public examination in the office of the Hearing Clerk, FDA (address above), and requests for single copies of the guideline may be made in writing to that office.

The Administrative Guideline provides the following instructions to FDA District Offices: "Recommend legal action to Division of Regulatory Guidance where the composite of fish or shellfish analyzed by the procedure outlined in the Twelfth Edition of the Official methods of Analysis of the Association of Official Analytical Chemists 25.103-25.107 shows:

Mercury (Hg)..... 1.0 ppm (edible portion only)

Note.—Recommendations for legal action must clearly indicate the exact portion of the food used for analysis. The portion used for analysis must be prepared by the appropriate procedure outlined in Volume 1 of the Pesticide Analytical Manual, §§ 141.12 and 141.22.

In addition to announcing the 1.0 ppm action level, this notice also informs interested persons of the availability of information the agency relied on in establishing the action level. Supporting documents also are available for public examination in the office of the Hearing Clerk, FDA.

Interested person may submit written comments (preferably four copies, each identified with the Hearing Clerk document number found in brackets in the heading of this document) of the guideline to the Hearing Clerk (HFA-305), Food and Drug Administration, Rm. 4-65, 5600 Fishers Lane, Rockville, MD 20857. Received comments will be incorporated into the public file on the guideline and may be seen in the above-named office between 9 a.m. and 4 p.m., Monday through Friday.

Dated: January 8, 1979.

DONALD KENNEDY,
Commissioner of Food and Drugs.

[FR Doc. 79-1742 Filed 1-18-79; 8:45 am]

[4110-03-M]

[Docket No. 78F-0412]

AMERICAN CYANAMID CO.

Filing of Food Additive Petition

AGENCY: Food and Drug Administration.

ACTION: Notice.

SUMMARY: American Cyanamid Co. has filed a petition (FAP 2167) proposing that the regulations be amended to provide for safe use of acrylamide-acrylic acid resin as a flocculant in nonmedicated aqueous suspensions intended for addition to animal feeds.

FOR FURTHER INFORMATION CONTACT:

Jack C. Taylor, Bureau of Veterinary Medicine (HFV-136), Food and Drug Administration, Department of Health, Education, and Welfare, 5600 Fishers Lane, Rockville, MD 20857, 301-443-5247.

SUPPLEMENTARY INFORMATION: Under the Federal Food, Drug, and Cosmetic Act (sec. 409(b)(5), 72 Stat. 1786 (21 U.S.C. 348(b)(5))), notice is given that a food additive petition (FAP 2167) has been filed by American Cyanamid Co., Wayne, NJ 07470, proposing that § 573.120 *Acrylamide-acrylic acid resin* (21 CFR 573.120) be amended to provide for the safe use of acrylamide-acrylic acid resin as a flocculant in nonmedicated aqueous suspensions intended for addition to animal feeds.

The environmental impact analysis report and other relevant material are being reviewed to determine whether the proposed use of the additive will have a significant environmental impact. In accordance with the provisions of § 25.25(b) (21 CFR 25.25(b)) of the environmental impact regulations, environmental impact consideration of the final action on this petition will be addressed in a future publication.

Dated: January 9, 1979.

LESTER M. CRAWFORD,
Director, Bureau of Veterinary Medicine.

[FR Doc. 79-1741 Filed 1-18-79; 8:45 am]

[4110-03-M]

[Docket No. 76N-0249]

SUCLIZINE HYDROCHLORIDE

Final Order on Objections and Request for a Hearing Regarding Approval of Supplemental New Drug Application

AGENCY: Food and Drug Administration.

ACTION: Notice.

SUMMARY: The Commissioner of Food and Drugs denies a hearing and refuses to approve the indications for Bucladin-S (NDA 10-911; DESI 9295) which lack substantial evidence of effectiveness. The drug is effective in the management of nausea, vomiting, and dizziness associated with motion sickness.

EFFECTIVE DATE: January 19, 1979.

FOR FURTHER INFORMATION CONTACT:

Ronald Kartzinel, Bureau of Drugs (HFD-120), Food and Drug Administration, Department of Health, Education, and Welfare, 5600 Fishers Lane, Rockville, MD 20857 (310-443-4020).

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